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A Comparative Study of Pain Perception in Mammography: The Impact of Compression Paddles

By

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ABBREVIATIONS

Sr no.	Abbreviations	Full Form
1.	WHO	WORLD HEALTH ORGANIZATION
2.	kVp	KILOVOLT PEAK
3.	mAs	HIGH MILLIAMPERE SECOND
4.	OD	OPTICAL DENSITY
5.	CC	CRANIOCAUDAL
6.	MLO	MEDIOLATERAL OBLIQUE
7.	CR	COMPUTED RADIOGRAPHY
8.	FFDM	FULL-FIELD DIGITAL MAMMOGRAPHY
9.	DBT	DIGITAL BREAST TOMOSYNTHESIS
10.	Mo	MOLYBDENUM
11.	Rh	RHODIUM
12.	HVL	HALF VALUE LAYER
13.	SID	SOURCE-TO-IMAGE RECEPTOR DISTANCE
14.	AEC	AUTOMATIC EXPOSURE CONTROL
15.	PSCM	PRESSURE STANDARDIZED COMPRESSION MAMMOGRAPHY
16.	FOV	FIELD OF VIEW
17.	NRS	NUMERIC RATING SCALE
18.	VAS	VISUAL ANALOGE SCALE
19.	IMD	IMPLANTED MEDICAL DEVICES

ABSTRACT

Objective- The primary aim of this study is to evaluate the level of pain and anxiety in women undergoing mammography investigation in Delhi NCR. This study also aims to investigate whether pre-existing knowledge about mammograms has an impact on the pain and anxiety of the patients.

Introduction- Mammography is widely available in many countries, and is a technique of choice for early diagnosis of breast cancer. Breast compression in mammography ensures high image quality with radiation dose reduction. Some women feel pain during or after compression during a mammogram. Because of this, they might be less likely to go for regular mammography screening and increased anxiety regarding pursuing mammography as a symptom of breast cancer. The increased anxiety can lead to an increase in pain and discomfort. However, the experience of pain during mammography is also influenced by the communication and support of the mammography technologist.

Methods- In this study, by using a questionnaire we collected information on pain experienced during mammography from 263 female and 7 male mammography participants in Delhi NCR. Pain was assessed by a numeric rating scale on 10 different levels. The data was collected through a simple random collection method by the direct interview immediately after the procedure.

Result- Among all the 270 participants 95.5% felt some amount of pain and discomfort and pain intensity was determined on a (0-10) Visual analog scale in which 4.4% of the participants were complaining of unimaginable level of pain, whereas 15.6% showed tolerable pain. maximum participants were between the age group of 40-69. Participants who were active smokers and those who consumed pain relievers whenever pain persisted, were having low pain/discomfort tolerance. Women with a history of abnormal test findings complain more pain compared to those who undergo regular checkup mammograms.

Conclusion- Most of the participants feel pain but male participants experience more pain/discomfort compared to females during mammography. Participants with the history of abnormal test results were less likely to tolerate the discomfort. Experience of the practitioner also play crucial role in balancing compression and technology.

Keywords- Mammography, Breast cancer, Pain, Discomfort, Anxiety, Pre-existing knowledge, Communication, Support, Technologist, Interview, Smokers, Pain relievers, Compression.

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CHAPTER-1

INTRODUCTION

1.1 OVERVIEW

Breast cancer is a top diagnosed cause of death for women all around the world. In 2022, the World Health Organization (WHO) announced that 2.3 million women had breast cancer Sadly, about 670,000 passed away from it globally[1]. This type of cancer can affect women at any age after they hit puberty. But it becomes more common as women grow older.

Did you know there's a 20% chance of getting breast cancer before you turn 75[2]. That's why taking steps to prevent it is super important! The way to screen for breast cancer is through mammograms. Early detection can really help because treating the disease sooner can lower deaths from breast cancer. However, mammography examinations can lead to several psychological phenomena in patients, such as anxiety or scared about the results. It can also be uncomfortable or painful during the mammogram due to the pressure put on the breasts. Usually, Breast cancer diagnosis involves a physician's physical examination along with mammography, a widely trusted method used globally for accurate detection[3].

Health groups like the American College of Radiology say that women with average risk should start getting yearly mammograms at age 40. The American Cancer Society has guidelines for different age groups too:

- **Women aged 40 to 44**: They can choose to start having yearly mammograms.
- **Women aged 45 to 54**: These ladies should get a mammogram once a year.
- **Women aged 55 and older**: They can choose to have one every two years or continue with yearly checks.

[1] World Health Organization: WHO & World Health Organization: WHO. (2024, March 13). *Breast cancer*. https://www.who.int/news-room/fact-sheets/detail/breast-cancer

[2] Ding S, Fontaine T, Serex M, Dos Reis CS. Strategies enhancing the patient experience in mammography: a scoping review. Radiography. 2024 Jan 1;30(1):340-52.

[3] Fuller MS, Lee CI, Elmore JG. Breast cancer screening: an evidence-based update. Med Clin North Am. 2015 May;99(3):451-68. doi: 10.1016/j.mcna.2015.01.002. Epub 2015 Mar 5. PMID: 25841594; PMCID: PMC5064844.

Mammography which is widely available in many countries, is a technique of choice for early diagnosis of breast cancer. Mammography is a diagnostic imaging technique, which involves taking pictures of the breast using a special X-ray machine fig 1.1. During the examination, a woman or sometimes a man has to stand at the machine and place one of her or his breasts on a plastic plate. The breast is then compressed against the plate by another plate and the X-ray is taken. Proper compression flattens the breast and makes it easier to spot abnormalities. The procedure is then repeated for other breasts and another view[4]. It is a prime example of soft tissue radiography. Radiographic imaging of soft tissues requires specialized techniques that differ from conventional radiography. These variations arise from the distinct anatomical characteristics of the tissues being examined. In conventional radiography, contrast is pronounced because of the significant differences in mass density and atomic number among bone, muscle, fat, and lung tissues. However, in soft tissue radiography, only muscle and fat are imaged, and these tissues share similar atomic numbers and mass densities, resulting in less natural contrast[5].

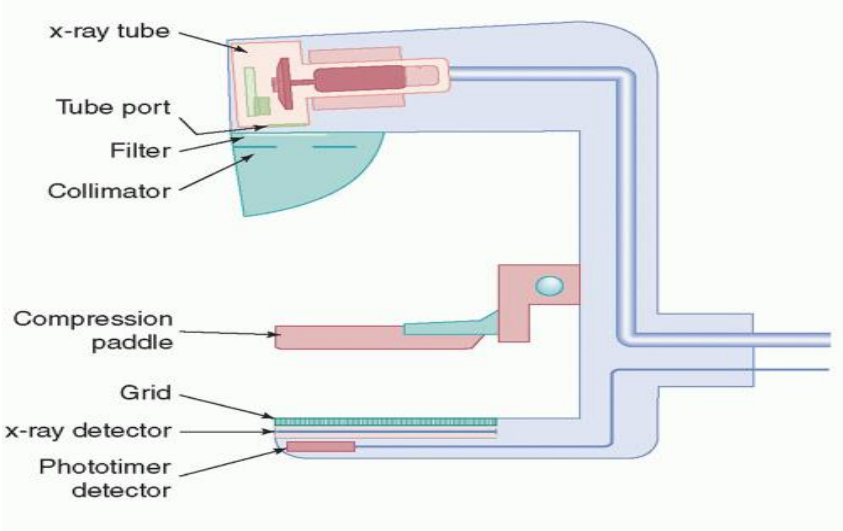

Figure No.1:- A mammography system has several special features. The main parts of a typical system, apart from the generator and control panel, are displayed.

[4] *Traditional vs. 3D mammography: Which is better for you?* (n.d.). City of Hope. https://www.cancercenter.com/community/blog/2021/08/traditional-3d-mammography

[5] Bushong, S. C. (2012). *Radiologic Science for Technologists - E-Book: Radiologic Science for Technologists - E-Book*. Elsevier Health Sciences.

Robert Egen demonstrates the successful technique of mammography that uses low kilovolt peak (kVp), high milliampere second (mAs), and direct film exposure since then mammography has undergone many changes over time. Another crucial factor in the effectiveness of mammography is the patient's radiation exposure, as radiation has the potential to both detect and cause breast cancer. The exact dose required to induce breast cancer remains unknown. However, research indicates that breasts in the mature screening age group have a very low sensitivity to radiation-induced cancer.

Several factors can make the risk of breast cancer higher:

- Age: The older you get, the greater your risk.
- Family history: If someone close to you, like your mom or sister, had breast cancer, your risk goes up.
- Genetics: If you have the BRCA1 or BRCA2 gene, you might be more likely to get breast cancer.
- Breast features: Having dense breast tissue or being overweight can increase the risk.
- Menstruation: Starting your period before age 12 may raise the risk.
- Menopause: If menopause starts after age 55, it can be linked to a higher risk.
- Estrogen use: Using estrogen for a long time might raise the risk too.
- Pregnancy: Having your first baby later in life—or not having kids at all—can be risky.
- Radiation: Getting radiation therapy on your chest when you're young raises the possibility of breast cancer.
- Education: Some evidence suggests that women with more education may face an increased risk of breast cancer.
- Staying aware of these factors is really important! If you're ever unsure about anything, talking with a doctor can help. They can guide you and give you more info[6].

[6] *Breast cancer - Symptoms and causes*. (n.d.). Mayo Clinic. https://www.mayoclinic.org/diseases-conditions/breast-cancer/symptoms-causes/syc-20352470#:~:text=The%20risk%20is%20higher%20if,personal%20history%20of%20breast%20cancer.

1.2 BREAST ANATOMY

If you want to understand breast cancer, prevention, risk, and diagnosis, it is important to know the kind of tissues and structure of the breast. Breast imaging is difficult because of its anatomy and tissue characteristics. Breasts are paired structures located on the anterior thoracic wall. They are present in both males and females and more prominent in females after puberty. The breast is primarily composed of glandular (milk-producing) and fatty tissues, with the ratio of these tissues varying among individuals. Estrogen, a key sex hormone, significantly influences the breast[7]. As menopause approaches and estrogen levels decline, there is a corresponding decrease in glandular tissue. The breast extends horizontally from the lateral edge of the sternum to the mid-axillary line, and vertically between the 2nd and 6th costal cartilages. It sits superficially on the pectoralis major and serratus anterior muscles. The breast can be divided into two regions: the circular body, which is the largest and most prominent part, and the axillary tail, a smaller portion that runs along the lower lateral edge of the pectoralis major towards the axillary fossa[8].

The breast is attached to the fascia of the pectoralis major muscle by Cooper's ligaments, which are flexible and allow for breast movement. However, over time and with age, these ligaments tend to stretch in most women, leading to breast sagging (ptosis). Gravity causes the lower portion of the breast to be fuller than the upper part. The tail of Spence extends into the axilla at the lateral edges of the breast. The nipple is generally positioned just above the inframammary crease, consistently aligning with the midclavicular line at the level of the fourth rib.

Cooper ligaments hold onto chest muscles & help the breast move around. But as women get older, these ligaments can stretch out, which can make breasts saggy. Gravity plays a role here too; so, usually, the bottom part of a breast looks fuller than the top. You can usually find the nipple just above where the breast folds under itself—this lines up with about the middle of your collarbone & sits at level with your fourth rib. The inner part of the breast is composed of glandular (milk-producing) and fatty tissues, with the ratio of these tissues varying based on age

[7] *Female breast*. (2023, November 3). Kenhub. https://www.kenhub.com/en/library/anatomy/breast
[8] *Redirecting*. (n.d.). https://teachmeanatomy-info.webpkgcache.com/doc/-/s/teachmeanatomy.info/thorax/organs/breasts/

and physiological conditions such as menopause, postpartum, or pregnancy. During menopause, the decrease in estrogen levels leads to a reduction in glandular tissue and an increase in fatty tissue[9].

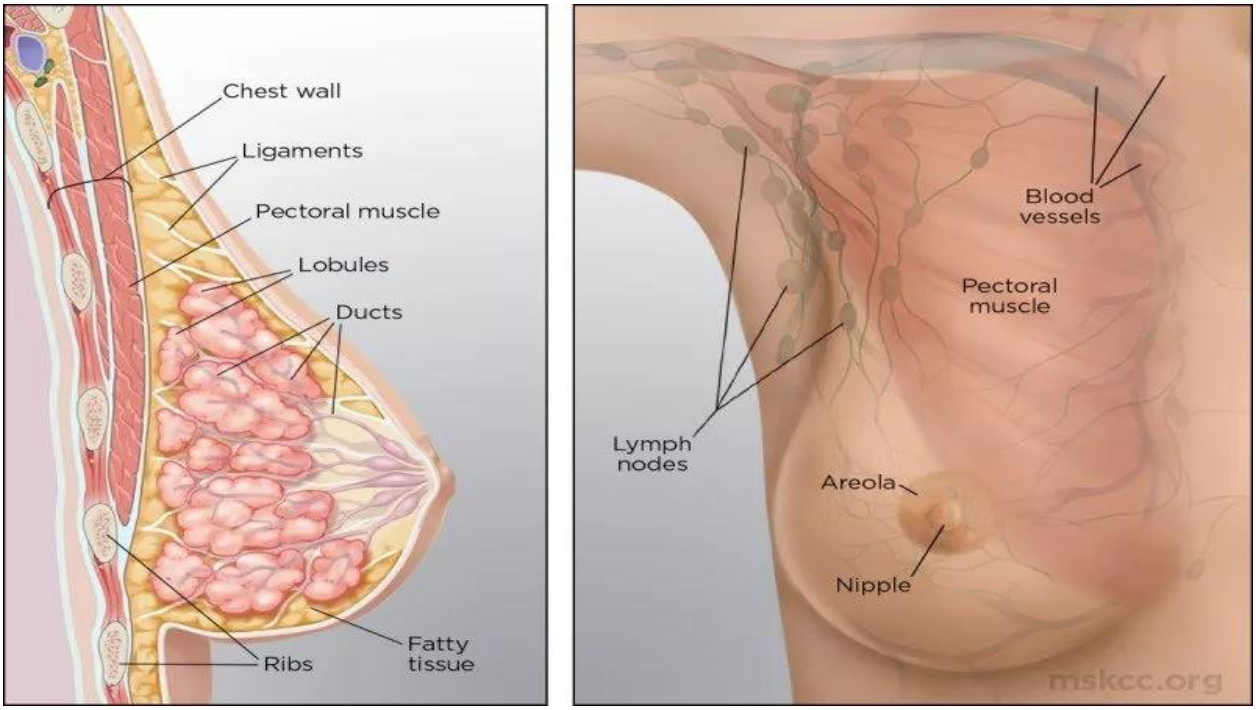

Figure No. 2:- Breast Anatomy- demonstrating various ducts, lobules, fatty tissues, blood vessels, lymph nodes, and muscles also determines the requirements for x-ray imaging systems and image receptors.

The mammary gland is an essential component of the female reproductive system, playing a crucial role in breastfeeding. A healthy breast is primarily made up of three types of tissue: fibrous, glandular, and fatty (adipose) tissue. In premenopausal women, the fibrous and glandular tissues form ducts, glands, and connective tissue, all surrounded by a thin layer of fat[10]. On a mammogram, glandular and connective tissues appear with a high optical density (OD).

[9] Rivard, A. B., Galarza-Paez, L., & Peterson, D. C. (2023, July 17). *Anatomy, thorax, breast*. StatPearls – NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK519575/

[10] Facs, A. G. M. (n.d.). *Breast anatomy: overview, vascular anatomy and innervation of the breast, breast parenchyma and support structures*. https://reference.medscape.com/article/1273133-overview

1.2.1 BLOOD SUPPLY AND LYMPHATICS

The breast skin receives blood from the subdermal plexus, which connects with deeper arterioles supplying the breast parenchyma. The blood supply to the breast comes from the following vessels:

- The Thoracoacromial Artery
- Internal mammary perforation (second and fifth)
- Lateral Thoracic Artery
- Thoracodorsal Artery
- Terminal branches of the intercostal perforators (third to eighth)

Overall, the superomedial perforators supply about 60% of the blood and originate from the internal mammary artery. The breast also has lymphatic drainage that runs both superficially and deep within the breast[11],[12].

1.2.2 NERVE SUPPLY

Sensory innervation to the breast is primarily provided by branches of the intercostal nerves T3-T5. Additional sensory innervation is supplied by the lower cervical plexus. The sensation to the nipple specifically comes from the lateral cutaneous branch of T4.

1.2.3 MUSCLES

The base of the breast sits on top of the serratus anterior and external oblique muscles on the sides of the chest.

- The pectoralis major is a large, fan-shaped muscle that starts from the side of the sternum and collarbone and attaches to the upper arm. It mainly gets its blood supply from

[11] Shahoud, J. S., Kerndt, C. C., & Burns, B. (2023, July 24). *Anatomy, thorax, internal mammary (Internal thoracic) arteries*. StatPearls - NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK537337/

[12] Cuadrado GD, de Andrade MF, Akamatsu FE, Jacomo AL. Lymph drainage of the upper limb and mammary region to the axilla: anatomical study in stillborns. Breast cancer research and treatment. 2018 Jun;169:251-6.

branches of the internal mammary and thoracoacromial arteries. The breasts rest on the pectoralis major and the upper part of the rectus abdominis muscle, covering the area between the second and sixth ribs. They are connected to the pectoralis major by Cooper's ligaments, which extend from the skin to the muscle. These ligaments allow the breasts to move naturally but can lose their tension with age, causing sagging.

- The serratus anterior is another fan-shaped muscle located on the side of the chest.
- The rectus abdominis muscle forms the lower edge of the breast and gets its blood supply from the inferior and superior epigastric vessels. In breast cancer surgery, a flap of this muscle (called the TRAM flap) is sometimes used, relying on the superior epigastric vessels.
- The external oblique is a muscle on the front and sides of the chest wall, supplied by the inferior intercostal vessels. This muscle forms the lower outer edge of the breast.
- In young women, the nipple is usually located just above the fold under the breast, at the level of the fourth rib and slightly to the side of the middle of the collarbone[13].

1.2.4 BREAST QUADRANTS

A single breast can be divided into four quadrants: UO upper outer, upper inner (UI), lower outer (LO), and lower inner (LI) by two perpendicular planes intersected at the nipple. The upper outer quadrant of the breast is the most common site of breast cancer occurrence. That would be the part of your breast nearest the armpit[14].

In female breast cancer, lumps are usually found near the armpit. In male breast cancer, lump are usually found near the nipple. Most lumps in the breast are noncancerous

[13] The Healthline Editorial Team. (2018, January 20). *Muscles*. Healthline. https://www.healthline.com/human body-maps/female-chest-muscles

[14] Du Cancer, C. C. S. /. S. C. (n.d.). *The breasts*. Canadian Cancer Society. https://cancer.ca/en/cancer-information/cancer-types/breast/what-is-breast-cancer/the-breasts

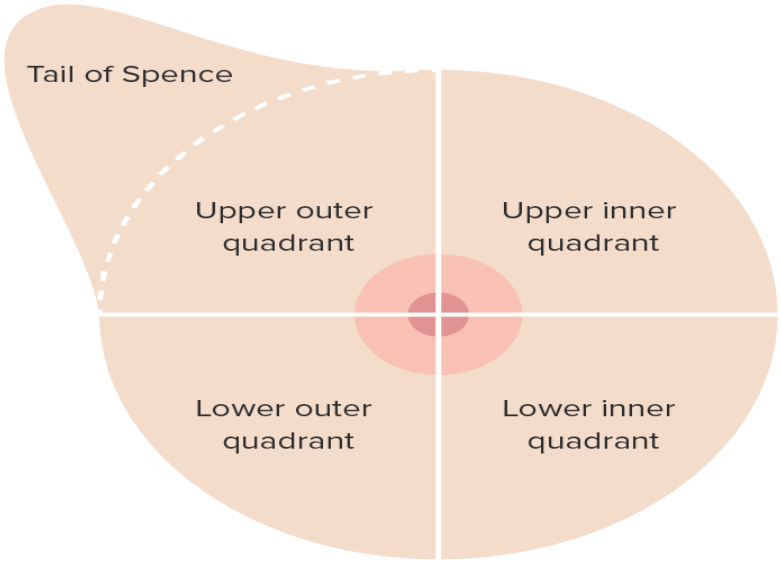

Figure No 3:- Showing different Quadrants of the Breast.

1.2.5 CLINICAL SIGNIFICANCE

The breast can experience various non-cancerous and cancerous conditions, including:

- Fibroadenoma: A fibroadenoma is a non-cancerous, painless breast tumor that appears as a solid, rather than fluid-filled, lump on one side of the breast. It is most frequently found in women aged 14 to 35 but can occur at any age. These tumors typically decrease in size after menopause, making them less common in post-menopausal women[15].
- Fibrocystic Breast Changes: These are very common and benign changes which is characterized by Extra connective tissue and/or fluid-filled cysts which can be present in one or both breasts and usually change over the course of the menstrual cycle[16].
- Breast Abscess: This is a painful swelling in the breast that appears pink or red and is filled with fluid and pus.

[15] Ajmal, M., Khan, M., & Van Fossen, K. (2022, October 6). *Breast fibroadenoma*. StatPearls - NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK535345/#:~:text=A%20fibroadenoma%20is%20a%20painless,common20in%20post%2Dmenopausal%20women.

[16] Malherbe, K., Khan, M., & Fatima, S. (2023, August 8). *Fibrocystic breast disease*. StatPearls - NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK551609/

- Inflammatory Diseases and Ductal Ectasia: Inflammatory conditions involve excess inflammation and can affect different body parts. Ductal ectasia is a non-cancerous condition affecting the large ducts in the breast, possibly related to aging. It elongates and weakens the duct walls, leading to symptoms like nipple discharge or a lump.
- Malignant Lesions: cancerous growths that multiply rapidly and have the potential to invade surrounding tissues or spread to other areas of the body via the bloodstream or lymphatic system[17].
- Breast Calcification: These are small calcium deposits in the breast tissue that are painless and too tiny to feel. While they are usually harmless, they sometimes indicate abnormal cell growth. Their further testing depends on the size, shape, and pattern of these calcification.

Breast Cancer - This is the leading cause of death among women and one of the most common cancers worldwide. Important risk factors have been identified, so it's essential for women over 45 to get regular mammograms, maintain a healthy diet, exercise, and avoid smoking.

Male Breast Conditions – Breasts in males develop from the same embryological cells as females, but males produce less estrogen and more androgens. In some men, an imbalance between these hormones can cause breast enlargement. About two-thirds of males experience temporary gynecomastia, which usually resolves within 24 months[18].

1.2.6 BREAST IMPLANTS

Breast augmentation or breast both are often used for one another. Breast augmentation is any cosmetic surgical procedure that makes breasts size enlarged. Breast implants are artificial devices that are surgically placed inside the breasts. They consist of silicone shells that can be filled with either silicone gel or saline solution. Many people get breast implants for restring

[17] *NCI Dictionary of Cancer Terms*. (n.d.). Cancer.gov. https://www.cancer.gov/publications/dictionaries/cancer terms/def/lesion

[18] *Breast enlargement in males: MedlinePlus Medical Encyclopedia*. (n.d.). https://medlineplus.gov/ency/article/003165.htm#:~:text=Breast%20enlargement%20is%20usually%20caused,cau %20enlarged%20breasts%20in%20males.

there previous breast size, correct asymmetrical (different size and shape) breast, restore breasts after mastectomy, affirm gender, and also boost confidence[19].

1.3 TYPES OF MAMMOGRAPHY

Mammography is an X-ray technique used to look at the breast to find cancer and other breast problems early on there are two basic types of mammographic examinations:- Screening and Diagnostic mammography.

Screening mammography is done on women who do not have any symptoms, using a method that takes two views of the breast, to identify the malignant breast pathology at an early stage potentially during the curable stage. It is done on the clients not on the patients.

Diagnostic mammography is used to look into cases where a mammogram is done on a patient who has symptoms. A baseline mammogram is the first X-ray of the breast, typically taken before a woman turns 40[20].

There has been a significant focus on the risk of breast cancer from radiation exposure due to X-ray mammography. However, mammography is considered very safe and effective, with an estimated benefit-to-risk ratio of 1000 to 1, meaning that for every 1000 lives saved, only one might be lost due to the procedure. The two standard views used in breast imaging are the craniocaudal (CC) and mediolateral oblique (MLO) projections. These views are used in both diagnostic and screening situations and can be done using different methods, including 2D imaging, film-screen, computed radiography (CR), full-field digital mammography (FFDM), or 3D digital breast tomosynthesis (DBT). The purpose of examining these images is to determine if the breast tissue looks normal or if there are any abnormalities that may indicate health issues.

[19] American Society of Plastic Surgeons. (n.d.). *Types of breast implants*. https://www.plasticsurgery.org/cosmetic procedures/breast-augmentation/implants

[20] *Mammograms*. (2023, February 21). Cancer.gov. https://www.cancer.gov/types/breast/mammograms-fact-sheet

1.3.1 MAMMOGRAPHIC VIEW

Mammography views can be generally categorized into two main types:

- Standard views
- Supplementary views, which provide additional details or are used for problem-solving.

Standard views in mammography include bilateral craniocaudal (CC) and mediolateral oblique (MLO) views, which form the basis of routine screening. These views are typically used for all regular screening patients, and unless there is a contraindication, a standard screening mammogram consists of these four views.

The craniocaudal (CC) view involves x-rays entering from the upper part of the breast and exiting through the lower part, with the breast positioned on the imaging receptor.

In mediolateral oblique (MLO) top of the compression paddle should be positioned just beneath the patient's clavicle, with the front edge of the paddle aligned against the sternum. The technologist, using both hands, should apply the "out and up" technique to properly position the breast on the detector, ensuring the nipple is in profile and the inframammary fold is clearly visible.

Additional (supplementary) views- These views are used in diagnostic breast workups in addition to the standard views. These includes-

- Spot compression,
- Axillary view,
- Magnification view(s)
- Tangential view,
- Eklund technique, and so on[21].

[21] Murphy, A., & Radswiki. (2011). Mammography views. *Radiopaedia.org*. https://doi.org/10.53347/rid-15023

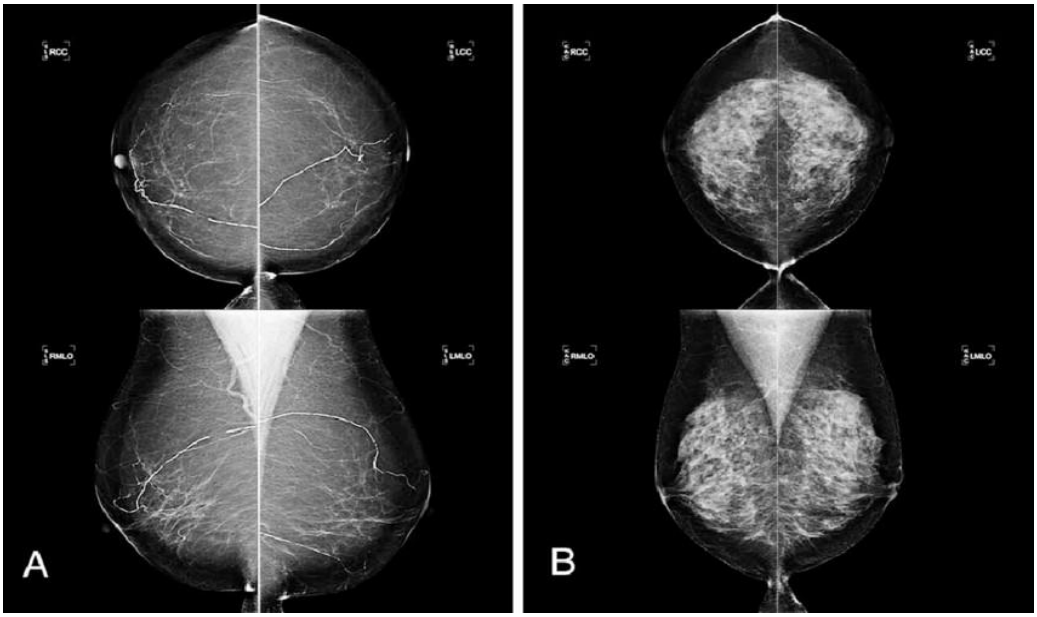

Figure No. 4:- showing different mammographic views. A) shows CC view of both left and right. B) shows MLO view for both breasts.

1.4 HISTORY

The first mammogram was performed in the 1970s using a small cassette with X-ray films to capture images of the breast. Since then, most healthcare facilities have shifted from film-screen to digital mammography. This technique uses digital detectors to create images, which are then stored electronically in a digital format. The images can be processed and shown as gray-scale pictures in various formats[22]. Digital mammography has several benefits over traditional film-screen mammography. It allows for faster image capture, display, and storage. Additionally, images can be adjusted for contrast, brightness, and magnification of specific areas. The improved contrast resolution makes it easier to screen women with dense breasts and breast implants, which is why many hospital radiology departments have adopted this newer technology.

[22] International Agency for Research on Cancer. (2016). *2. Screening techniques*. Breast Cancer Screening – NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK546557/

1.5 THE MAMMOGRAPHIC IMAGING SYSTEM

1.5.1 X-RAY TUBE

A specialized mammography X-ray tube is similar to a regular X-ray tube in many ways. However, this section highlights the main differences between mammography tubes and those used in general radiography.

1.5.2 CATHODE AND FILAMENT CIRCUIT

The mammography X-ray tube has two filaments in the focusing cup, which aloe it to produce focal spot sizes of 0.3 mm and 0.1 mm. The 0.1 mm size is used for magnification studies to minimize geometric blurring. The operating voltage of mammography is very low, below 40 kV and this distinguishes it from the operation of a conventional x-ray tube. As the x-ray tube voltage is so small, feedback circuits are required in the high-tension section of the generator to alter filament current as a function of kV (as filament and tube cu, the filament current is limited to control the tube current, usually to 100 mA for the larger (0.3 mm) focal spot and 25 mA for the smaller (0.1 mm) focal spot. This helps prevent overheating of the molybdenum (Mo) or rhodium (Rh) targets because they have smaller interaction areas. In contrast, tungsten anodes can handle higher filament and tube currents, exceeding 200 mA for the large focal spot and 50 mA for the small focal spot[23].

1.5.3 ANODE

Mammographic x-ray tube targets are manufactured with the material of tungsten (W), molybdenum (Mo), or rhodium (Rh). Mo and Rh Targets Are Chosen for Breast Imaging:

1. Characteristic X-Ray Production-Mo (Molybdenum): K-shell x-ray energies of 17.5 and 19.6 keV and Rh (Rhodium): K-shell x-ray energies of 20.2 and 22.7 keV.

These x-rays are in the optimal energy range for breast imaging, significantly increasing the number of useful x-rays. W (Tungsten) Is Becoming Popular with Digital Detectors:

1) Better X-Ray Production Efficiency: This is because it has a higher atomic number.
2) Enhanced Heat Handling: This is due to its higher melting point.

[23] Bushberg, J. T., Seibert, J. A., Leidholdt, E. M., & Boone, J. M. (2011). *The essential physics of medical imaging*. Lippincott Williams & Wilkins.

Most mammography x-ray tubes are equipped with rotating anodes that vary in angle from the nominal 16 degrees to as little as zero, depending on the manufacturer. The position of the tubes are usually at a source-to-image receptor distance (SID) of 65 cm. x-ray tube tilt) which has a minimum effective anode angle of 22 degrees as needed for anterior field coverage with the 24 x30 cm FOV. To achieve an effective angle of about 24 degrees, the anode angle should be set at 0 degrees and the tube tilted to roughly 24 degrees[24]. The intensity of the X-rays produced from the focal spot differs across the beam because of the heel effect, with the strongest intensity on the cathode side and the weakest on the anode side. Placing the cathode over the patient's chest wall and the anode over the nipple helps create a more even distribution of X-rays through the breast. This setup also minimizes the equipment's bulk near the patient's head.

1.5.4 TUBE PORT

The tube port and added filters are important for shaping the energy spectrum of X-rays in mammography. The tube port window is made of beryllium, which has a low atomic number (Z=4) and a thin layer (0.5 to 1 mm). This allows most of the low-energy bremsstrahlung X-rays (under 5 keV) to pass through. Mo, Rh targets create useful K-characteristic X-ray peaks at 17.5 and 19.6 keV (Mo) and 20.2 and 22.7 keV (Rh), while tungsten targets produce many unwanted L-characteristic X-rays in the 8 to 10 keV range.

1.5.5 FILTRATION AND BEAM QUALITY

Additional X-ray tube filtration improves the energy distribution by removing both the lowest and highest energy X-rays, allowing the desired energies to pass. This is done using materials with K-absorption edge energies between 20 and 27 keV, like Mo, Rh, and silver (Ag), which can be made into thin, uniform sheets for filtering. The filtration provides strong attenuation for low X-ray energies. For a Mo target, a typical filter is a 0.030-mm-thick Mo filter, while a Rh target uses a 0.025-mm Rh filter. For tungsten targets, various filters are used, including Rh (0.05 mm), Ag (0.05 mm), and aluminum (0.7 mm).

To get the best effective X-ray energy for breast imaging, adjustments are made by choosing the anode material, filter material, and kV settings. Screen-film detectors usually use a Mo target

[24] Skalski, M., & Nadrljanski, M. (2010). Anode (x-ray tube). *Radiopaedia.org*. https://doi.org/10.53347/rid-8178

with 0.03-mm Mo filtration and a kV of 24 to 25 for thin, fatty breasts, while thicker, glandular breasts require up to 30 kV. For denser breasts, a Mo target with Rh filter and higher kV settings (28 to 32 kV) provide a higher effective energy and a more penetrating beam[25].

Tungsten targets are now often used in digital mammography systems because they produce more bremsstrahlung and can handle greater loads compared to Mo and Rh targets. K-edge filters can optimize the energy spectrum for breast imaging. However, an unfiltered tungsten spectrum includes a lot of unwanted L X-rays in the 8 to 12 keV range.

1.5.5 HALF VALUE LAYER

The half-value layer (HVL) of a mammography X-ray beam typically ranges from 0.3 to 0.7 mm of aluminum, depending on the combinations of target materials, filter materials, and filter thicknesses used. It is usually measured with a compression paddle using 0.1-mm thick, 99.9% pure aluminum sheets. For instance, using a molybdenum target with a 0.03-mm molybdenum filter at 28 kV and a 1.5-mm Lexan compression paddle gives an HVL of about 0.35 mm of aluminum.

Different machines may have varying HVLs due to differences in filter thicknesses and kV settings. The HVL for breast tissue also varies significantly based on its composition, such as whether it is glandular, fibrous, or fatty, as well as the HVL of the incoming X-ray beam[26]. Generally, the HVL for breast tissues ranges from 1 to 3 cm, and the American College of Radiology (ACR) has recommended maximum HVL limits for accreditation purposes.

1.5.6 X-RAY TUBE ALIGNMENT AND BEAM COLLIMATION

It's important to align the X-ray tube and collimator correctly so that the central axis of the X-ray beam is perpendicular to the image receptor and hits the center of the chest wall edge. This alignment minimizes unnecessary radiation exposure to the lungs and maximizes the inclusion of breast tissue in the image. The X-ray beam is shaped using fixed metal openings or adjustable shutters. In standard screen-film imaging, the field dimensions generally correspond to the size

[25] Jones, J., & Goel, A. (2014). Filters. *Radiopaedia.org*. https://doi.org/10.53347/rid-29737

[26] Ishii, R., Yoshida, A., Ishii, M., Fujimoto, S., & Henmi, N. (2011). The precision of half-value layer measurement on mammography. *Japanese Journal of Radiological Technology*, *67*(12), 1533–1539. https://doi.org/10.6009/jjrt.67.1533

of the film cassette, such as 18x24 cm or 24x30 cm. For a larger digital detector (24x30 cm), one of three active areas (center, left shift, or right shift) is used when employing the smaller field size (18x24 cm). This requires the collimator to limit the X-ray field to the active detector area. Field shifts can help optimize images of oblique views in smaller-breasted patients, ensuring their arm and shoulder fit at the top edge of the cassette.

There's no downside to using full-field collimation compared to only focusing on the breast tissue since the beam is fully restricted to the tissues. For magnification and spot compression images, manually adjusted shutters help align the X-ray field more precisely with the area being examined.

1.5.7 X-RAY GENERATOR

The design and function of a dedicated mammography x-ray generator is similar to the conventional x-ray generator. Variations are decreased applied x-ray tube voltages, space charge compensation and automatic exposure control (AEC) circuitries. AEC for mammography screening and diagnostic examinations and sometimes technologies also uses manual control to set the tube current. Mammography utilizes high-frequency generators, as do the majority of present-day x ray imaging systems because they provide low voltage ripple, fast response time and are easy to calibrate due or their long-term stability plus small size. Circuitry preventing x-ray exposures if equipment is not properly set up (e.g. compression inadequate, cassette out of the tunnel or the digital detector unable to make an image). A maximum limit of 600 mAs is standard for preventing excessive patient radiation dose[27].

1.5.7.1 PHOTOTIMER SYSTEM (Automatic Exposure Control)

In order to regulate the exposure, the AEC relies on a radiation sensor, a charge amplifier, and most commonly of all voltage comparator. The phototimer sensor for cassette-based image receptors (screenfilm and CR) is under the cassette, It has either one ionization chamber or several semiconductor diodes. The X-rays that go through the breast, the anti-scatter grid, and the image receptor create a signal in the detector. The detector continuously collects this signal

[27] Murphy, A., & Gaillard, F. (2008). Mammography. *Radiopaedia.org*. https://doi.org/10.53347/rid-1644

and stops the exposure when it hits a predetermined limit for the accumulated image. This limit is set to achieve a specific signal-to-noise ratio (SNR) in digital mammography systems or an acceptable optical density OD in film-screen systems.

Phototimer algorithms consider factors like the thickness of the compressed breast, settings on the generator console, kV and tube anode selection, and the tube filter to determine the right radiographic technique for achieving the desired film OD. An operator generally has two or three alternatives for AEC: Automatic mode with pre-selected conditions (kV and filtration – target material in some systems) optimized from a short test 100 ms exposure to assess the penetrability of the breast; (b) automatic kV with short exposure but the user can choose target, filter values; (C) automatic exposure time using manually selected target, filters and kv value. Any exposure time that is not stopped by AEC and exceeds a predetermined time (like 5 s) must stopped by a backup timer. This can happen if kV is much too low which limits x-ray transmission. To correct the problem, in this case: This can be corrected by making use of a higher kV which will have capable of penetrating the beam easily and hence reducing your exposure time[28].

Phototimer mismatch can occur due to heterogeneous breast tissue, improper compression thickness, or a faulty cassette, leading to under- or overexposed images, and can be affected by inadequate kV settings. Prior mammograms assist in optimizing detector positioning for maximum film density (or peak SNR) in the glandular region. Phototimer placement is typically anterior to the chest wall but can also vary from side to side[29].

1.5.8. COMPRESSION PADDLE

The compression paddle is a device used in mammography machines to compress the breast. It has a flat, transparent plate that sits parallel to the support table and is connected to either a mechanical or air-driven system. Polycarbonate (PC) is the most commonly used material for this purpose in clinical settings because it is heat-resistant, durable, fire-resistant, and clear, making it suitable for various uses. The operator can control the paddle with a foot pedal.

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[28] Jones, J., & Vajuhudeen, Z. (2020). Automatic exposure control. *Radiopaedia.org*. https://doi.org/10.53347/rid 79836

[29] Bushberg, J. T., Seibert, J. A., Leidholdt, E. M., & Boone, J. M. (2011). *The essential physics of medical imaging*. Lippincott Williams & Wilkins.

1.5.8.1. TYPES OF COMPRESSION PADDLE

Basically, there are two main types of compression paddle.

- Full compression paddles:- designed to compress the entire breast and correspond to its dimensions. The full-field paddle aligns with the size of the image receptor, typically 18x24 cm or 24x30 cm. It has a flat surface and sits parallel to the table supporting the breast. A variation of these flat paddles available on the market is the "flex" paddle.
- Spot compression paddles:- These paddles are small in diameter, usually around 5 cm and compress a specific region of the breast[30].

Mammography paddles come in different sizes, such as small round ones with a diameter of 7.5 cm and larger quadrant paddles that can be square (10 cm) or rectangular (15 cm)[31]. Smaller paddles are designed for targeted compression, while larger paddles are better for covering bigger or spread-out areas as shown in fig-1.5. A compression paddle with a right-angle edge helps flatten the breast evenly when a force of 111 to 200 newtons (25 to 44 lbs) and pressure of 10.3 to 13.5 kPa are applied. Due to this women may experience discomfort during or after a mammogram. While compression is crucial for image quality, there are no widely accepted guidelines on the best compression techniques, fig-6 shows some of these compression techniques according to the thickness of the tissues, target material, and selected voltage. The Mammography Quality Standards Act (MQSA) states that compression should be within 111 to 200 newtons. European guidelines recommend that compression should be "firm but tolerable" to ensure comfort while achieving the required image quality. Local regulations set limits on the minimum and maximum compression force to avoid injuries from excessive pressure while ensuring good image quality. Discomfort during the procedure may lead some women to skip future mammograms or screenings; studies show that 25-46% of women reported pain from compression as a reason for not returning for their next screening.

[30] Spuur K. A review of mammographic lesion localisation and work up imaging in Australia in the digital era. Radiography. 2019 Nov 1;25(4):385-91.

[31] Spuur, K. (2019). A review of mammographic lesion localisation and work up imaging in Australia in the digital era. *Radiography*, *25*(4), 385–391. https://doi.org/10.1016/j.radi.2019.03.002

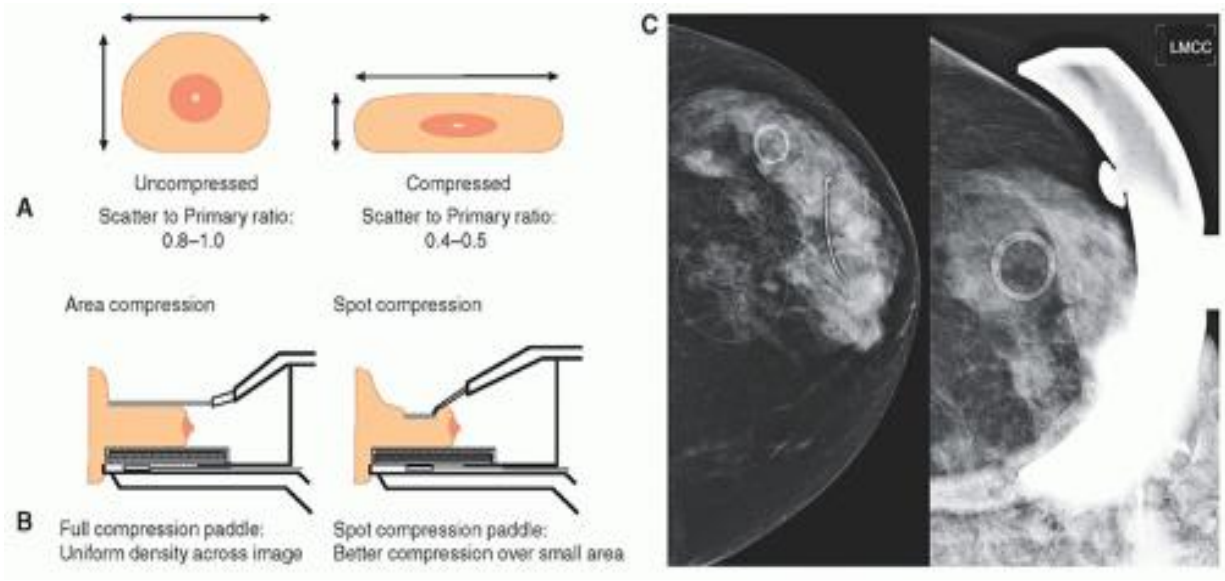


Figure No. 5:- A. Demonstrates breast compression. B. Areas that appear suspicious may need "spot" compression to remove overlapping structures. C. The image on the left shows a suspicious finding, while the spot compression image reveals no visible mass or distortion in the structure.

TABLE 8-5 TECHNIQUE CHART FOR A DIGITAL MAMMOGRAPHY SYSTEM WITH SELENIUM DETECTOR FOR 50% GLANDULAR 50% ADIPOSE COMPOSITION

	DIGITAL, Mo TARGET, CELLULAR GRID			DIGITAL, W TARGET, CELLULAR GRID			DIGITAL TOMOSYNTHESIS, W TARGET, NO GRID		
THICKNESS (cm)	FILTER	kV	mAs	FILTER	kV	mAs	FILTER	kV	mAs
<3	Mo 30 μm	24	35	Rh 50 μm	25	40	Al 700 μm	26	35
3–5	Mo 30 μm	27	75	Rh 50 μm	28	80	Al 700 μm	29	50
5–7	Mo 30 μm	31	100	Rh 50 μm	31	150	Al 700 μm	33	65
>7	Rh 25 μm	33	150	Ag 50 μm	32	200	Al 700 μm	38	85

Figure No 6:- shows the compression technique according to the tissue composition and the material used.

1.5.8.2. COMPRESSION

Whatever detector type is used, compression of the breast is an essential component of a mammographic examination. Stronger compression reduces the overlapping of anatomy, decreases the thickness of tissues, and limits breast motion. It leads to fewer other X-ray scatter, and Reduced geometric blurring of anatomical structures leads to a lower radiation dose to breast tissues. When breast thickness is uniform, it also helps minimize the exposure range, permitting greater contrast film to be used, or more image processing enhancement for the digital substitute. The compression is done via a compression paddle, which is simply a large Lexan plate on the end of some sort of mechanical device.

1.5.8.2.1 TYPE OF BREAST COMPRESSION

There are several types of breast compression techniques used in mammography, including:

Rigid and flexible compression:- Mammography machines often offer both rigid and flexible paddles. The flexible paddles conform to the shape of the breast during compression, enhancing comfort for the patient.

Patient-controlled compression:- Some women may prefer to manage the compression level during the exam. A remote control device allows them to adjust the compression themselves[32].

Standardized compression:- Studies indicate that following a standardized compression protocol based on pressure can accommodate individual breast characteristics. A compression pressure of approximately 10kPa has been shown to reduce discomfort without compromising image quality.

1.5.8.2.2. FORCE AND PRESSURE-STANDARDIZE COMPRESSION

Current compression practices use a standardized force, meaning each breast is compressed within a specific range of recommended pressures. However, this approach doesn't consider breast size, which can lead to differences in the pressure applied. Research by De Groot et al. (2015) indicated that women with smaller breasts might feel more pressure and pain during mammograms than those with larger breasts.

[32] Ulus S, Kovan Ö, Arslan A, Elpen P, Arıbal E. A new technical mode in mammography: self-compression improves satisfaction. European Journal of Breast Health. 2019 Oct;15(4):207.

In this method, the mean pressure, which is the ratio of force to the area in contact, is kept consistent, allowing the compression force to adapt to the breast size. However, the pressure-standardized protocol significantly reduced pain, Average pain scores have dropped by 10% in the MLO view and 17% in the CC view. Recently, a new compression paddle called the Sensitive Sigma was created to improve breast compression during mammograms. This paddle uses multiple sensors to measure and monitor pressure in real-time, targeting an ideal compression level of 75 mmHg[33].

1.5.9. ANTISCATTER GRID

Scattered radiation reaching the image receptor can be minimized by using either an antiscatter grid or an air gap technique. An antiscatter grid is positioned between the breast and the detector. These grids allow 60-70% of the primary X-rays to pass while blocking 75-85% of the scattered radiation. Standard grids have a grid ratio of 4:1 to 5:1, with carbon fiber used as the spacer material. Grid frequencies typically range between 30 and 45 lead strips per centimeter. To avoid grid-line artifacts, the grid must move slightly during exposure, and short exposure times may cause these artifacts.

An air gap technique reduces scatter by increasing the distance between the breast and the detector, causing more scattered radiation to miss the detector. However, this method can limit the field of view, increase the magnification of the breast, and result in a higher radiation dose.

1.5.10. MAGNIFICATION TECHNIQUE

Geometric magnification is utilized to improve the resolution of the system, frequently aiding in the clearer observation of microcalcifications. This technique involves placing a breast support platform, also known as a magnification stand, at a set height above the detector, choosing a small focal spot (0.1 mm), removing the antiscatter grid, and using a compression paddle. The advantages of using magnification include: (a) enhanced effective resolution of the image receptor due to the magnification factor; (b) reduced image noise in relation to the objects being

[33] Jeukens CR, Van Dijk T, Berben C, Wildberger JE, Lobbes MB. Evaluation of pressure-controlled mammography compression paddles with respect to force-controlled compression paddles in clinical practice. European radiology. 2019 May 1;29:2545-52.

examined; and (c) lower levels of scattered radiation. The space between the breast support surface and the image receptor helps minimize the amount of scattered radiation that reaches the receptor. This improvement in image contrast and reduction in random noise makes the use of an antiscatter grid unnecessary[34].If the field of view (FOV) is smaller when using magnification, it is appropriate to collimate the X-ray beam to focus solely on the area of interest, which helps decrease both radiation scatter and the overall dose to the breast.

1.5.11. DIGITAL MAMMOGRAPHY

Digital mammography refers to the method of capturing radiographic images using digital detectors that store the data electronically. This image can then be processed and displayed in gray scale, allowing it to be viewed in various formats. There are several benefits to digital mammography, including improved image quality compared to conventional screen-film detectors and reduced radiation doses. It minimizes radiation exposure while still delivering high-quality imaging results.

1.5.11.1 DIGTAL BEAST TOMOSYNTHESIS

One significant challenge of traditional projection imaging is that overlapping anatomical structures can obscure the visibility of tumors or other abnormalities, making detection difficult. To address this issue, multiple low-dose images are captured from different angles as the X-ray tube moves in an arc around the breast. This technique, known as Tomosynthesis or "3D" mammography, is an advanced digital X-ray method that creates both 2D and 3D-like images of breast tissue.

During a "3D" mammography exam, an X-ray arm moves in a gentle arc over the breast, collecting several low-dose X-ray images. A computer then processes these images to generate synthetic 2D and 3D representations of the breast tissue. Each image captures the breast content from various distances relative to the detector, allowing for better depth perception. With rapid digital readout, a series of projection images can be obtained in less than 10 seconds, and each set of images undergoes a limited-angle reconstruction algorithm to create in-focus tomograms at

[34] Stewart, E. (2016). Air gap technique (mammography). *Radiopaedia.org*. https://doi.org/10.53347/rid-50102

specific depths within the breast. This results in multiple tomograms that enhance the detection of abnormalities, such as tumors, while minimizing the effects of overlapping anatomical features that could mimic these issues[35].

Digital tomosynthesis for breast imaging utilizes fast-read Thin Film Transistor arrays to capture a large number of sequential images (ranging from 11 to 51) within a limited angle (7.5 to 50 degrees) in a brief period (4 to 20 seconds). During this process, the X-ray tube moves through a restricted arc while the breast is compressed, allowing for a series of exposures to be taken..

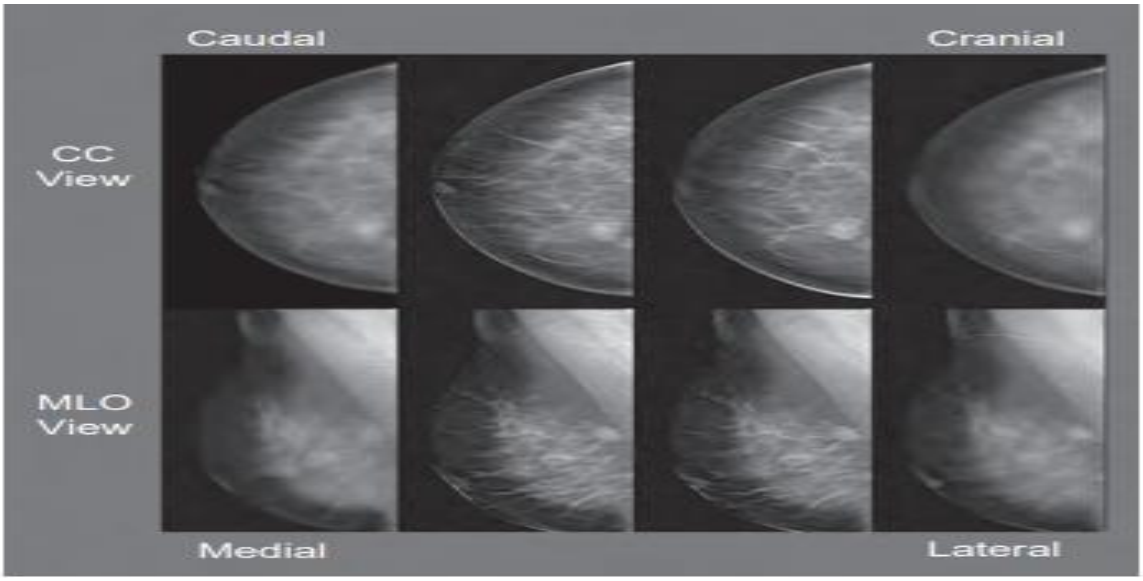


Figure No. 7:- Digital tomosynthesis image of both CC and MLO view

1.5.12. PATIENTS ANXIETY DUE TO COMPRESSION FORCE

Breast compression during mammography is crucial for obtaining high-quality images, minimizing blurring, and lowering radiation exposure for women undergoing the procedure. However, some women may experience discomfort or pain during or after the compression, which can lead to decreased attendance at mammography screenings and heightened anxiety

[35] Murphy, A., & Pacifici, S. (2011). Digital breast tomosynthesis. *Radiopaedia.org*. https://doi.org/10.53347/rid 15235

regarding breast cancer symptoms. The perception of pain during mammography can be affected by factors such as the communication between radiographers and patients, the equipment used, and the overall environment. Currently, there is limited information about how these factors interact, making it challenging to recommend the most effective compression techniques.

A significant source of anxiety for patients stems from a lack of understanding about the procedures and how they are used to diagnose health issues. To alleviate unnecessary worry, it is vital to educate patients about the diagnostic process. Anxiety is a widespread concern across various medical diagnoses, treatments, and care situations. While patients have the right to be informed about diagnostic and treatment options, education often receives insufficient attention. Proper communication can help lower anxiety levels and prevent patients from developing negative coping mechanisms. Therefore, it is essential to assess patients' anxiety levels and the factors that influence them when preparing for procedures like mammography. Research has shown that heightened anxiety is associated with increased pain and discomfort during the procedure[36],[37].

1.5.13. TECHNOLOGIST'S PERSPECTIVE

Early detection of breast cancer is crucial as it allows for the management of potentially curable conditions, ultimately reducing mortality rates associated with this disease. However, the experience of undergoing a mammogram can lead to various psychological responses, including anxiety, fear regarding the results, discomfort, and pain from breast compression. During the exam, the breast is compressed to its thinnest state for each of the four projections taken—two for each breast in the craniocaudal and mediolateral oblique views. This compression is vital for minimizing radiation exposure and ensuring image quality, which helps to avoid the necessity for additional views or examinations. Unfortunately, this can result in discomfort or pain, which may discourage women from participating in regular screenings, significantly affecting the early detection and treatment of breast cancer.

[36] Paap E, Witjes M, van Landsveld-Verhoeven C, Pijnappel RM, Maas AH, Broeders MJ. Mammography in females with an implanted medical device: impact on image quality, pain and anxiety. The British Journal of Radiology. 2016 Oct 1;89(1066):20160142.
[37] Aldhafeeri F, Abozeed MT. Anxiety and Pain Level Associated with Mammography and the Impact of the Preexistence of Knowledge. Journal of Cancer Research. 2020;8(2):25-32.

To mitigate these concerns, healthcare professionals have implemented strategies to enhance the mammography experience. For example, providing education about the procedure can help reduce anxiety and offer reassurance. Allowing patients some control over the compression process, using flexible paddles, or incorporating cushioning into the paddles can also alleviate pain. Researchers have worked on gathering data regarding the challenges of mammography compression and have organized this information into several steps.

Initially, the mammography request is assessed, and the patient's preliminary thoughts on the required compression force are taken into account. Typically, patients with symptoms tend to tolerate compression better due to their different mindsets. Additionally, factors like age and menopausal status can impact the physical characteristics of breast tissue. Some studies suggest a more cautious approach with younger women, while one participant emphasized the importance of explaining the procedure thoroughly. Furthermore, various studies indicate that older patients often report experiencing more breast pain[38].

First impressions- The initial impression of a client is made as soon as they enter the mammography room, influencing the selection of equipment, adjustments to technique, and the required compression levels. To maintain the client's dignity, the assessment of their size and shape prior to undressing plays a crucial role in deciding which compression paddle to use. As someone might express, "I assess her size even before she changes, making estimates based on that.

Explanation and consent- Both compliance and client empowerment are crucial for a successful examination. A quick assessment of the client's anxiety is made: "As soon as the lady enters the room, you get a general sense of how anxious or calm she is." If the client is extremely anxious, the practitioner's compression force plan may be adjusted, often reducing it.

Handling the breast and positioning- An experienced practitioner can assess the required compression and potential discomfort by touch and feel. A poor positioning makes applying compression force challenging. Clients with dense breasts and those who have undergone radiotherapy are often more sensitive and less able to tolerate higher compression

[38] de Groot JE, Broeders MJ, Grimbergen CA, den Heeten GJ. Pain-preventing strategies in mammography: an observational study of simultaneously recorded pain and breast mechanics throughout the entire breast compression cycle. BMC women's health. 2015 Dec;15:1-9.

forces. As one mammography educator noted, "Without good positioning, compression could be a total waste of time."

Applying compression force- The application of compression force involves visual cues, tactile sensations, and client feedback. Participants unanimously agree that touch is the most important aspect, as it helps gauge the breast's tautness. Client feedback during positioning is crucial: "You're watching the woman's expression—you don't want her wincing or uncomfortable." Practitioners describe using a "gentle coaxing" approach to ensure sufficient compression is applied**.**

Final adjustments

During the "fine-tuning" stage, many participants switch to manual compression, which is considered more sensitive and gentle. As one participant noted, "You can feel it more because you're turning the knob—you can sense the pressure and the resistance.[39]

By understanding and implementing these strategies, healthcare providers can make mammography more comfortable and less stressful, thereby increasing patients' willingness to undergo regular screenings and reducing the burden of breast cancer.

[39] Moshina N, Sagstad S, Sebuødegård S, Waade GG, Gran E, Music J, Hofvind S. Breast compression and reported pain during mammographic screening. Radiography. 2020 May 1;26(2):133-9.

CHAPTER - 2

NEED FOR STUDY

Mammography is a crucial diagnostic tool for early detection of breast cancer, significantly improving patient outcomes. However, the procedure often involves discomfort or pain due to the compression of breast tissue using compression paddles. This discomfort can discourage some women from undergoing regular mammograms, potentially leading to delayed diagnoses and poorer outcomes.

Pain Perception as a Barrier to Screening:- The perception of pain during mammography is a significant barrier to participation in regular screening programs. Understanding and addressing this issue is critical to increasing compliance with recommended mammography schedules. By analyzing pain perception in relation to the type of compression paddles used, this research can contribute to developing more patient-friendly technologies and techniques.

Variability in Pain Perception: Pain perception is subjective and can vary widely among individuals due to factors such as breast size, tissue density, and psychological aspects like anxiety. Analyzing these variables in the context of mammography can help identify specific groups of women who are more likely to experience pain.

Improvement of Technological Designs:- Current mammography equipment may not adequately account for the comfort of all patients. Researching how different compression paddles impact pain perception can provide insights into how these tools can be improved. This may lead to the development of new paddle designs or alternative methods of breast compression that minimize discomfort without compromising image quality. By analyzing pain perception, it can be assessed how different paddle designs, materials, and compression techniques affect patient comfort

Enhancing Patient Education and Comfort: The findings from this research could also inform better patient education and preparation strategies, potentially reducing anxiety and pain associated with mammography. Educating patients about what to expect and providing them with strategies to manage discomfort could lead to improved experiences and higher screening rates.

CHAPTER-3

AIM AND OBJECTIVES

AIM

Comparative Study of Pain Perception in Mammography: The Impact of Compression Paddles.

OBJECTIVE

1. To evaluate the level of Pain experienced based on different gender, age groups, and different signs & symptoms.
2. To study the roles of emotional, cognitive, and personality factors on the experience of Pain and unpleasantness during mammographic procedures.
3. To assess the participants' preexisting knowledge and experience of mammography in assisting the patient during the procedure.

CHAPTER-4

REVIEW OF LITERATURE

4.1- N. MOHSINA et al. (2023): Experience of pain during mammographic screening by three different compression paddles

This study is designed to compare the pain levels experienced by women during mammography using three different types of paddles: a fixed paddle, a flexible paddle, and a fixed paddle that maintains standardized compression pressure (the study paddle). It also aims to evaluate image quality based on positioning parameters for each paddle type. Pain during screening mammography has been shown to negatively affect future attendance rates. Mohsina et al. conducted research involving 938 women who were screened at Nordland Hospital County in Bodø in 2018 as part of BreastScreen Norway, utilizing a self-report questionnaire to gather data on pain levels. Pain was assessed using a numeric rating scale (NRS) ranging from 0 to 10. For each screening, one of three types of paddles was used: a fixed paddle, a flexible paddle, and a study paddle that maintained standardized pressure. The radiographers measured and documented the compression force (in kg) applied during each session. To assess the relative risk (RR) of experiencing severe pain (≥7 on the NRS) compared to mild or moderate pain (<7 on the NRS), log-binomial regression analysis was performed, considering factors such as breast tenderness, pre-existing neck or shoulder pain, compression force, age, body mass index, and screening history. The average pain scores reported were 2.8 for the fixed paddle, 2.3 for the flexible paddle, and 2.8 for the study paddle, with significant differences noted ($p < 0.03$) between the fixed and flexible paddles as well as between the flexible and study paddles. After adjustments, the relative risk of experiencing severe pain was found to be higher for both the fixed and study paddles in comparison to the flexible paddle. Furthermore, women with breast tenderness were at an increased risk of reporting severe pain compared to those without tenderness. Overall, women who underwent screening with the flexible paddle reported less pain than those who used either the fixed or study paddles.

4.2-CASANDRA I. MONTORO (2023): Experiencing discomfort and distress during mammography screening: a cross-sectional investigation into the influence of emotional, cognitive, and personality traits.

This cross-sectional study was conducted in Switzerland to observe, that the degree of participation in screening mammography is influenced by psychological factors including fear, unpleasantness, Pain, and anxiety. In this study total of 26 women participated and were observed in 2 phases. In the first phase - prior to the Mammogram, breast pain intensity and unpleasantness were evaluated using a visual analogue scale (VAS) along with physiological and personality factors via self-reporting questionnaires. In the second phase, during screening, the intensity of the unpleasantness of the Pain in each mammographic projection was measured using the VAS Scale. Immediately after the study, the level of anxiety and the residual breast pain were re-evaluated. It results in the level of Pain and perceived unpleasantness during mammography, which is higher than both pre-screening and post-screening. Anxiety was higher in pre-screening compared to post-screening. The study concluded that the anxiety level influences the experience of Pain, which is associated with the mammographic procedure.

4.3- S. L. GAUCI (2023): Survey of knowledge and awareness of breast density amongst Maltese Women undergoing mammography screening

This study focused on breast density, which is the proportion of glandular to fatty tissue in the breast, and evaluated the knowledge and awareness of this topic among Maltese women undergoing mammography at the National Screening Unit. Raising awareness about breast density could potentially increase attendance for additional imaging. With few studies available on breast density awareness in Europe, this research offers important local insights. Women between the ages of 50 and 69, eligible for breast cancer screening at the National Screening Unit, participated by completing a validated closed-ended questionnaire. This was part of a quantitative, prospective, cross-sectional, and descriptive study. The questionnaire was tailored to fulfill the study's objectives, and data were analyzed using IBM SPSS software. In total, 127 surveys were collected, resulting in a maximum margin of error of 8.66% within a 95% confidence level. While the participants showed a lack of understanding regarding breast density

and its related risks, they demonstrated a greater familiarity with supplemental screening techniques. Knowledge and awareness levels were affected by factors including age, occupation, and educational background. Respondents preferred leaflets and medical professionals as sources of information. The findings reveal a significant gap in knowledge regarding breast density and its related risks among the study population. Therefore, it is essential to provide women with more information about breast density to empower them in seeking optimal care.

4.4- HALA TAHA SALEM (2023): Pros and cons of pre mammography examination technique description of pain in mammography and Re-attending Screening Program

HalaTaha Salem et al. focused a study of 'Pros and Cons of Pre Mammography Examination Technique Description on Pain in Mammography and Re-attending Screening Program' at the Department of Health and Radiation Research in 2023, which was published in the "Egypt Journal of Radiation Sciences and application'' which is pub med listed with impact factor 0.7. The purpose of this study was to determine the benefits and drawbacks of explaining the mammography examination technique to women participating in screening programs. The goal was to decrease the need for repeat tests, minimize radiation exposure, and boost the number of women who returned the following year for follow-up mammograms—a total of 306 women. Two sets of women One group went to a lecture on the mammography method, whereas the other group went straight to the mammography. According to the study's conclusion, there is a highly significant correlation (P value = 0.000) between attending a lecture and showing up the following year.

4.5- S. DING (2023): Strategies enhancing the patient experience in mammography: A Scopic review

The objective of this study was to enhance the patient experience in diagnostic or screening mammography that has been assessed. A positive experience in mammography is essential for improving both patient attendance and reattendance for these examinations, whether they are

conducted for diagnostic or screening purposes. Mammograms play a crucial role in the early detection of diseases, which increases the chances of successful treatment and ultimately contributes to reducing breast cancer mortality. The strategies were grouped into eight categories, with the most common being breast compression and positioning, followed by relaxation techniques, analgesic care, communication and information, screening equipment, examination procedures, patient-related factors, physical environment, and staff characteristics.

4.6- WEI-YING-SUNG (2022): Experiences of women who refuse recall for further investigation of abnormal Screening Mammography: A Qualitative Study.

This research aims to educate the general public about breast cancer awareness, with medical personnel playing a crucial role in improving follow-up rates for abnormal screening mammograms. This study raising breast cancer awareness and improving follow-up rates for abnormal mammograms, with medical personnel playing a key role. In Taiwan, breast cancer is the most common cancer among women, and the current policy offers biennial mammograms for women aged 45 to 69. However, follow-up rates after abnormal results have dropped below 92.5%. This study interviewed 13 women who declined further investigation after an abnormal screening. Three themes emerged: negative screening experiences, indecision about follow-up, and rationalizing their refusal. These insights highlight the need for better education and support from healthcare providers to improve care outcomes.

4.7- VIDYA R PAI (2021): How to minimize patient anxiety from screening mammography

The media and some organizations have portrayed anxiety as a harm of mammography. However, anxiety is common with many medical tests, including other screening exams, and is not unique to mammography. Some may argue that because the anxiety is temporary, its impact is overstated, but for some women, it is significant. Anxiety can affect whether a woman decides to get a screening mammogram. There are various ways to reduce anxiety related to screening

mammography, including steps taken before, during, and after the exam. These measures include patient education, better communication, addressing and acknowledging the patient's discomfort and anxiety, and providing facial information. These steps can be easily implemented in every breast cancer. More complex interventions include changing the breast center environment with multisensory stimulation, reorganizing patient flow to reduce wait time, and using relaxation techniques, including complementary and alternative medicine. This article will review the literature on ways to reduce anxiety and increase the likelihood of women getting annual screening mammography.

4.8- NERIMAN AKANSEL (2021): Influence of discomfort tolerance of women who undergo mammography on the perceived pain intensity due to the procedure.

The aim of this study is to assess the capacity for discomfort tolerance by women who undergo mammography. Compression applied to breast tissue during mammography is necessary for image quality but often causes Pain and discomfort. Factors such as cold compressor material, claustrophobia, lack of empathy from healthcare staff, inadequate information, and delays in reporting can lead patients to postpone mammography. Negative experiences during the procedure impact patients' compliance, satisfaction, and comfort. Even the anticipation of negative outcomes can influence pain perception and satisfaction. Embarrassment and discomfort during mammography can create lasting negative impressions. Studies, like that of Whelehan et al., show that 3%-46% of British women avoid follow-up mammography due to previous Pain and discomfort. Pain during mammography can extend beyond the breast to the axilla and is influenced by factors such as ethnicity, breast density, previous biopsy experiences, psychological factors, and the presence of breast implants. Raousoft sample size calculator was used to calculate the sample size, with 90% reliability and 5% error. The data were obtained using a demographic data form developed by researchers. Among the patients, 78.8% experience pain during mammography, and pain intensity was determined on the 0-10 Visual Analog Scale. Women who were not on pain relievers and non-smokers have high discomfort tolerance.

4.9- D.J. NELSON (2020): A comparative study of Pain experienced during successive mammography examinations in patients with a family history of breast cancer and those who have had breast cancer surgery.

This study aimed to measure mammography-related Pain in two groups of women undergoing regular surveillance, establish a baseline for future care, and assess any prolonged physical effects a week after the procedure. After receiving ethical approval, 242 women aged 32-84 years (average age 54) were invited by letter to participate in the study. Of those invited, 200 women agreed to take part—100 with a family history of breast cancer and 100 who had undergone conservative surgery for breast cancer and were currently symptom-free. Participants rated their Pain using a validated pain scale before compression (based on memory), immediately after compression, and one week later. Baseline data such as compression force, breast size/density, menstrual history, and any adverse events following mammography were also collected to explore potential relationships. There was a strong correlation ($r = 0.79$, $p < 0.001$) between previous and current pain scores. However, no significant correlations were found between Pain and factors like breast size, breast density, or total compression force. Although pain scores decreased between previous and current examinations, overall pain levels remained consistent despite differences in the compression forces applied. Physical side effects from mammography can develop and persist beyond the examination period. In this study, the only significant predictor of current Pain was the patient's prior experience of Pain.

4.10- MONIQUE G.J.T.B. VAN LIER (2020): pressure-based compression guidance of the breast in digital breast tomosynthesis using flexible paddles compared to conventional compression

Vanlier and colleagues studied how using a flexible paddle that applies pressure affects the compression process and the experiences of both users and patients during digital breast tomosynthesis (DBT), whether the compression is done by the patient or by a technologist. After the review of the institution, the board approved that women scheduled for a DBT appointment who provided informed consent underwent breast compression using a pressure-based flexible paddle. As pressure was applied, eight lights on the paddle were illuminated, aiming for a target

range of 8–13.9 kPa. Pressure variability decreased in both craniocaudal (CC) and mediolateral oblique (MLO) views. Subgroup analysis showed that glandular dose remained similar for CC views, while breast thickness was reduced. For MLO views, both glandular dose (-0.13 mGy, $P < 0.0001$) and breast thickness were reduced. The average compression parameters were comparable between technologist-assisted and patient assisted exams. The use of a pressure-based flexible paddle in DBT, whether with or without patient-assisted compression, enhanced the experience for both participants and technologists while also reducing compression pressure variability, mean breast thickness, and glandular dose.

4.11- N. MOHSINA et al. (2020): Breast compression and reported Pain during mammography screening.

This retrospective study focused on compression force and pressure and reported Pain among women who attended mammography screening in Akershus, Norway. In this study, information on Pain experienced during mammography has been collected through a questionnaire. The questionnaire provides information on Pain using a numeric rating scale (NRS, 0-10) and some related factors. Information was taken from 1155 women who were screened in Akershus from February 2018 to March 2018 as a part of Breast Screen Norway. Data like compression force (N), pressure (KPa) and breast characteristics were expected from the DICOM – header and breast density software. 70 determine the relative risk of severe versus mild/moderate experience of Pain associated with compression parameters, adjustment for breast characteristics, log-binomial regression was used. The average pain score during the examination was 2.2, with 6% of women reporting severe Pain. Women with a high BMI had a higher relative risk of experiencing increased Pain compared to those with a medium BMI. After adjusting for contact area, age, compressed breast thickness, volumetric breast density, and BMI, low compression pressure was associated with a higher relative risk of severe Pain than medium compression pressure. Additionally, each unit increase in compression force reduced the risk of severe Pain versus mild or moderate Pain by 2%. Women reported low levels of Pain during mammography. Further knowledge about factors affecting experienced Pain is needed to personalize the examination to the individual woman.

4.12- AFATEN ALDHAFEERI (2020): Anxiety and Pain Level Associated with Mammography and the Impact of the Preexistence of Knowledge

Breast cancer is the most common cancer among women, following skin cancer. Early detection and treatment are crucial for reducing mortality and suffering. Despite this, many women avoid screening due to factors like anxiety and stress. Mammography is the primary recommended test for early breast cancer detection. This study aimed to evaluate women's knowledge, pain levels, and stress associated with early breast cancer screening through mammography. This study, approved by the Local Research Ethics Committee, was conducted at HafrElbatin Central Hospital in Saudi Arabia with 100 women. Data were collected through a structured interview questionnaire administered before and immediately after the mammography procedure. The questionnaire included three sections: (1) sociodemographic data and knowledge about mammography, (2) a pain scale, and (3) an anxiety scale. Data were entered and analyzed using SPSS version 25. Seventy-five percent of women reported moderate to severe Pain during the Mammogram, and 57% experienced severe anxiety about the procedure. Eighty-five percent had poor knowledge about mammograms and their preparation. There was a strong correlation between Pain experienced before and during the procedure (p-value with Chi-squared test) and a significant link between knowledge levels and satisfaction (p-value with z-test). Overall, women, especially those who had never had a mammogram, lacked knowledge about breast cancer risk factors. Incorrect beliefs about mammography were the main barriers. Addressing pain expectations and enhancing knowledge is crucial to improving the mammography experience and encouraging regular screenings.

4.13- C.R.L.P.N. JEUKENS (2019): Evaluation of pressure-controlled mammography compression paddles with respect to force-controlled compression paddles in clinical practice.

Mammography is the standard method for breast cancer detection, traditionally using a force-controlled compression paddle. A new pressure-controlled paddle was developed to compress the breast based on contact area. This retrospective study of 3,188 patients (2014–2016) and a prospective study of 343 patients compared both paddles. Results showed no significant

differences in compressed breast thickness (CBT), compression force, pressure, or pain scores between the two methods. Median pain scores were 6 for the force-controlled paddle and 5 for the pressure-controlled paddle, with no clinically relevant differences, providing no clear preference for one paddle over the other.

4.14- D.J. NELSON (2019):-A comparative study of Pain experienced during successive mammography examinations in patients with a family history of breast cancer and those who have had breast cancer surgery

The objective of this study was to assess the level of Pain associated with mammography in two groups of women undergoing routine surveillance, providing a baseline for future care, and examining any lingering physical effects a week after the Mammogram. In this study, 242 women aged 32 to 84 years (mean age 54) were invited to participate in the study via written invitation. Of these, 200 women were accepted: 100 with a family history (FH) of breast cancer and 100 who had undergone conservative surgery (FU) for breast cancer and were currently asymptomatic. A validated pain scale was used to assess participants' pain levels based on memory before compression, immediately after compression, and one week later. Baseline data, such as compression force, breast size/density, menstrual history, and any adverse events post-mammography, were also collected to explore potential correlations.A strong correlation was observed between previous and current pain scores, but no significant relationships were found between breast size, breast density, or total compression force and pain levels. Pain scores decreased between the previous and current exams, and overall pain levels remained consistent, even with differences in the compression forces used. Physical side effects from mammography can persist beyond the examination period. In this study, prior pain experience was the only significant predictor of current Pain.

4.15-PHILIPPE HENROT, MARTINE BOISSERIE-LACROIX (2019): Self-Compression Technique vs Standard Compression Technique in mammography

The main purpose of this study is to assess whether the self-compression mammography technique is inferior to standard compression in reducing breast thickness. Despite the utility of mammography, many women have a fear of undergoing mammography because this examination can be uncomfortable or painful. In many studies, it is also found that about 25% to 46% cases women does not re-attend their mammography because of the Pain perceived. The Pain experienced during mammography is often due to the positioning of the breast, which is necessary to obtain a clear and reproducible image. Compression is key to image quality in mammography, but no guidelines define the optimal technique. The Mammography Quality Standards Act requires compression between 111 and 200 N, while European guidelines recommend "firm but tolerable" compression. In a prospective study (2013–2015) involving 549 women aged 50–75 in France, self-compression was compared to standard compression. Self-compression resulted in higher compression force and significantly less pain, with no difference in image quality or additional views. No adverse effects were reported, suggesting self-compression is a viable, effective, and comfortable option for women during mammography.

4.16- SILA ULUS (2019): A new technical mode in mammography self compression improves satisfaction

The study aims to assess patients' experiences with mammography using a manually operated self-compression tool in comparison to their previous experiences where breast compression was performed by a technician. This was done through a questionnaire survey. A retrospective review was conducted on survey data from 365 patients who underwent screening or diagnostic mammography at our centre between April and July 2017. Each participant completed a 12-item questionnaire after their mammography exam. Patients who had never undergone a mammogram before had their last Mammogram over two years ago or chose not to use the self-compression device were excluded. A total of 106 women were included in the study. Patient satisfaction was high, with 70.8% of participants reporting a better experience compared to previous exams. The

exam was comfortable for 85.4%, and 75.5% found it more comfortable than prior ones. Anxiety levels were low, with only 11.3% feeling anxious, and 52.8% experiencing less anxiety compared to earlier exams. Regarding the new design, 66.9% found it attractive, 39.7% preferred it over previous designs, and 27.3% felt it reduced anxiety. Regarding patient-assisted compression (PAC), 80.2% found it more comfortable, 64.2% reported less anxiety, and 72.6% noted the exam was shorter.The self-compression technique reduces Pain and anxiety for women during mammography exams and holds the potential for improving patient adherence to follow-up mammography recommendations.

4.17- GREESHMA A. AGYASTYA (2018): Can Breast compression be reduced in digital mammography and breast tomosynthesis?

The main focus of this study is to decrease in breast compression in digital mammography and breast tomosynthesis on Pain and image quality. This study was completed in two parts in which two groups of women with their prior mammograms were considered. They observed the relationship between compression force, breast thickness, tissue coverage, image quality, and patient-perceived discomfort or Pain during mammography using a Digital breast tomosynthesis system. In part one, all the participants were positioned for craniocaudal (CC) and mediolateral oblique (MLO) views. Four levels of compression force were applied to evaluate changes in breast thickness, perceived Pain, and relative tissue coverage, although no imaging was performed. In part 2, two mediolateral obliques (MLO) Digital Breast Tomosynthesis (DBT) images of one breast of each patient were acquired on both standard and reduced compression. The study demonstrated that only the first reduction in force was the only one that worked, as further reductions made it hard to keep the breast still. On average, reducing the force by about 48% for the CC view and 47% for the MLO view led to significantly less Pain. The thickness of the breast increased slightly—by 0.02 cm in the CC view and 0.09 cm in the MLO view (part 1 of the study), and by 0.38 cm in the MLO view (part 2 of the study). However, these changes did not affect the tissue coverage or cause any motion blurring. Mammography and DBT acquisitions may be possible using half of the compression force used currently, which would greatly reduce Pain without causing any noticeable changes in breast thickness or tissue coverage

4.18- D. DEN BOER (2018): Clinical validation of a pressure-standardized compression mammography system.

The main focus of this study is the validation of a Pressure Standardized Compression Mammography (PSCM) system designed to reduce discomfort and Pain by applying uniform pressure to every breast, regardless of breast size. This retrospective study compares mammograms from 39 patients acquired using the conventional Force-Standardized Compression Mammography (FSCM) technique to those obtained during a checkup visit with the Pressure Standardized Compression Mammography (PSCM) technique. Each patient received one craniocaudal (CC) and one mediolateral oblique (MLO) compression for both breasts. All images were processed to determine the contact area between the breast and the compression paddle, with pressure calculated by dividing the compression force by the contact area. A total of 150 images from both FSCM and PSCM techniques were analyzed. The mean pressure significantly decreased from 17.1 kPa to 12.8 kPa with PSCM compared to FSCM. In PSCM, the applied pressure showed minimal dependence on the breast contact area with the paddle, unlike in FSCM, where a clear dependency was observed. Additionally, the incidence of over-compressions dropped from 26% to 2%, which particularly benefited patients with smaller breasts. The study suggests that PSCM can reduce patient discomfort and Pain during mammographic compression compared to conventional FSCM due to its lower average pressure. Additionally, standardized pressure may enhance image quality consistency, potentially improving diagnostic performance.

4.19- HOLLAND et al. (2017): Influence of Breast compression pressure on the performance of population-based Mammography screening

As we all know compression is applied in mammography to reduce the thickness of the in order to improve image quality and to reduce the risk of motion artifacts and image blurring. Mammography devices measure and display impression force during imaging, but there are no clear guidelines on how much force should be used. The amount of compression force applied can vary gradually between radiographers screening centres and countries. One downside is that many women experience discomfort and Pain, which can deter them from participating in

screening readings. The compression force has been suggested to increase screening attendance. Although the mammography system displays the compression force applied to the breast, it is the pressure (force divided by the impact area) that determines tissue compression. The pain women experience during mammography is likely more related to pressure them to force the same force results in different depending on breast size and intact area, which changes with breast deformation during compression. It was found that Pain with pressure while the average glandular dose remains unchanged, but there is no such quantitative parameter present which indicates the correct amount of compression. In the retrospective study, mammograms were acquired from women between 50 & 75 years of age who are invited for a screening examination every 2 years. These images were required at the loradselenia system between 2003 - 2012 were had 2 views MCO & CC. As pressure increased, percent dense volume rose while breast volume decreased. Sensitivity across pressure quintiles was 82.0%, 77.1%, 79.8%, 71.1%, and 70.8%, respectively. Sensitivity for detecting interval cancers within 12 months was significantly lower in the highest pressure quintile compared to the third quintile. Specificity was also lower in the lowest pressure quintile.Results suggest excessive pressure during mammography may reduce sensitivity, while insufficient pressure may decrease specificity.

4.20- ELLEN PAAP, MARLOES WEITJES (2016): Mammography in females with an implanted device: impact on image quality, Pain, and anxiety.

The study aims to assess the image quality of mammograms in women with implanted medical devices (IMDs), evaluate their pain and anxiety levels during mammography, and explore the experiences of radiographers performing these procedures. In this study, image quality was evaluated by 2 radiographers and 1 radiologist in females with IMD. Pain and anxiety were scored using a numeric rating scale in both clients visiting a screening organization and patients from the isala hospital zwollle. Experience of screening radiographers was collected with a questionnaire. Breast images with an implanted medical device (IMD) showed reduced contrast in both craniocaudal (CC) and mediolateral-oblique (MLO) views, with less projected breast tissue and reduced visibility of the pectoral muscle, as noted by both radiographers and radiologists. Patients reported experiencing more Pain and anxiety during mammography of the breast with an IMD compared to the breast without an IMD. Additionally, pain and anxiety

levels were higher after the placement of the IMD. Radiographers were more cautious, experienced increased anxiety, and used less compression when performing mammography on breasts with an IMD. Image quality in the breast with IMD could be improved by projecting more breast tissue on the Mammogram, thereby including the IMD between the paddles, if required. In addition, radiographers should pay sufficient attention to reducing discomfort both before and after the examination.

4.21- JERRY E DE GROOT (2015): Pain-preventing strategies in mammography: an observational study of simultaneously recorded pain and breast mechanics throughout the entire breast compression cycle

This paper aims to gain insights into current and potential new pain-prevention strategies in mammography by simultaneously monitoring pain levels and breast mechanics throughout the entire breast compression cycle. This observational study included 117 women at the Academic Medical Center in Amsterdam, The Netherlands, who consented to use a custom turning knob to indicate their pain experience during standard mammographic breast compressions. Throughout the procedure, breast thickness, compression force, contact area, contact pressure, and pain experience were recorded continuously, while breast volume was retrospectively calculated from the mammograms. We visualized the progression of Pain about breast mechanics across five different breast volume groups and performed multivariable regressions to identify factors that significantly predict pain experience. During the clamping phase, the average pain score on a 0–10 Numerical Rating Scale (NRS) increased from 4.75, and the proportion of women experiencing severe Pain more than doubled, rising from 23% to 50%. Some women reported Moderate Pain for up to four days after the Mammogram. Multivariable analysis revealed that pain recollection from a previous mammogram and pre-existing breast pain were significant predictors of Pain during the procedure. Women with the smallest breasts experienced the most Pain, as they were subjected to the highest contact pressures (force divided by contact area) and the most rapid increase in pressure. In conclusion, further research should focus on two potential pain-prevention strategies: 1) implementing a personalized compression protocol that applies the same target pressure at a consistent, slow rate for all breasts, and 2) reducing the duration of the clamping phase.

4.22- J.M. NIGHTINGALE (2014): Breast compression - An exploration of problem-solving and decision-making in mammography.

Breast compression during mammography plays a crucial role in reducing radiation dose and minimizing the potential for motion and geometric unsharpness. However, there is significant variability in the amount of compression force applied within and between different centres. This article delves into the problem-solving process employed by mammography practitioners when determining the appropriate level of breast compression force. A qualitative analysis was conducted using a comprehensive data set of transcribed interviews and focus groups from a phenomenological study on mammography practitioner values, behaviours, and beliefs. The data were gathered from focus groups held at six NHS breast screening centres in England (n = 41 participants) and semi-structured interviews with mammography educators (n = 6). The researcher employed a thematic content analysis to extract data related to problem-solving in mammography compression, developing a series of categories, themes, and sub-themes. The emerging themes were peer-validated by two additional researchers and subsequently developed into a model of practice. The problem-solving process for applying compression force in mammography involves seven consecutive stages: assessing the request, first impressions, explanations and consent, breast handling and positioning, applying compression force, final adjustments, and feedback. This model encapsulates the steps of information gathering, problem framing, and decision-making to achieve an 'ideal' compression scenario, reflecting behavioural problem-solving, heuristics, and intuitive decision-making. The application of compression in mammography should no longer be viewed as a single task but is now recognized as a seven-stage problem-solving continuum.

4.23- ACLAIRE E. MERCER (2014): A 6-year study of mammographic compression force: Practitioner variability within and between screening sites.

Claire, E. Mercer, and colleagues focus on the research to investigate the variation of compression force in 3 different screening units by different practitioners over 6 years. The study contains 975 clients who have to have three consecutive screening events, with their first recorded mammogram experience as their first event. Each one of them has four standard

projections: CC (Cranio-caudal) for both left and right, MLO (medio-lateral) for both left and right. Information related to the size of the film, breast compression force value in (daN and N), compressed breast thickness (mm) and the practitioner who performs the Mammogram are taken from the Mammogram of each client. Breast density on all three units was observed by 4 point BIRAD Scale. Two of the three sites demonstrate variability within themselves, though they demonstrated no significant difference in mean, first and third quartile compression force and breast thickness values CC ($p > 0.5$), MLO ($p > 0.1$) between themselves. Significant variation in compression forces could negatively affect the client experience both within and between units.

4.24- MAGNUS DUSTLER (2012): Breast compression in mammography: pressure distribution patterns.

Mammographic breast compression is used to immobilize the breast, separate superimposed tissue components and reduce scattered radiation. This process helps in two key ways – It reduces the radiation absorption by glandular tissue and facilitates image interpretation, and a negative aspect of compression is Pain and, as a result, lower acceptance importantly, lower attendance in screening programs. Breast tissues are fibro glandular, more and less fatty, show an exponential decrease in the state of thickness while increasing pressure, and there is no significant reduction in clinical quality of the image was found. In this study, a total of 131 subjects were included from October 18 to November 19, 2010, in which 103 subjects with a mean age of 48.9 years were included with the approval of the informed consent. The women were subjected to 2 additional compressions without X-ray exposure, full standard compression force 77 – 112 N, as well as a reduced force 34 – 67 N. The subjects were asked to rate their experience of Pain at full and reduced compression on a visual analogic scale (VAS) immediately after compression pressure distribution was measured by a 7-scan system. In which the sensor sensitivity can be adjusted, but higher pressure resolution reduces the saturation limit. At the recommended limit of 35 KPa, pressure resolution is 0.14 KPa, least was used to analyze the difference between full and reduced compression and ANOVA was used for non-parametric data. The study shows that the force is derived from the force recorded by the compression devices.

4.25- MERYEM YILMAZ(2010): Anxiety and Pain associated with process mammography: influence of process information before.

The main focus of this study is to assess the impact of providing information through a leaflet to women scheduled for mammography on their anxiety levels before the procedure and their pain levels afterwards." data was collected from 63 women before they went to mammography unit and a leaflet was given to them with a written information on it by using the personal characteristic form, State Trait-Anxiety Scale and Verbal category scale. Anxiety level was measured twice, and pain level was measured after the procedure. There was no significant difference in anxiety levels between the experimental group (46.19±11.88) and the control group (46.41±12.73) in the breast clinic before their mammograms ($p>0.05$). However, in the mammography unit, the experimental group (35.35±10.30) had significantly lower anxiety levels than the control group (51.41±10.59, $p=0.00$). After the mammography, there was no significant difference in pain levels between the two groups ($p>0.05$). It was determined that giving information using written leaflets to women who will have mammography has decreased levels of anxiety. However, it did not affect pain level.

4.26- DAWN MILLER (2009): Interventions for relieving the pain and discomfort of Screening mammography.

This study focused on mitigating the pain and discomfort linked to screening mammography. The pain experienced during mammography is a notable barrier for many women contemplating the exam, potentially impacting their participation in breast cancer screenings. Researchers Dawn Miller and V Livingstone reviewed existing studies to determine whether they met the inclusion criteria, specifically looking at evaluations of pain or discomfort and assessing if the interventions might influence the quality of mammograms. Their findings suggested that providing women with pre-procedure information could help alleviate pain and discomfort. Additionally, allowing women more control over breast compression was found to potentially reduce pain; however, optimal image quality was only maintained when the technologist managed the initial compression. Reducing the compression force by the technologist did not significantly affect discomfort levels. While breast cushions were beneficial in lowering pain,

they did compromise image quality in 2% of cases. The use of acetaminophen as a premedication showed no impact on discomfort during the procedure. Due to the variability in interventions, inconsistent measurement techniques, validation of pain scales, and assessments of mammogram quality, the results from these studies cannot be combined. Thus, the findings are based on individual studies, highlighting the necessity for further research.

4.27- STACY M. SMALLEY (2003): Implant and Cancer Screening in Mammograpgy.

Breast implants become a priority issue in breast cancer detection. This review article reveals the influence of implants on early detection methods of breast cancer, i.e. sel,f-examination, clinical breast examination and mammography. Nearly around 2 million women in the US have undergone mammoplasty. Breast implant surgery can be either aesthetic or reconstructive. Complications from breast implantation are also categorised into two – early onset is related to surgery involving inflammation, swelling, erythema, etc., whereas late-onset includes capsular contracture deflation or rupture and wrinkling. The presence of breast implants complicates both the execution and interpretation of mammography, as implants appear radiopaque on the imaging films. However, research involving women with breast implants has not indicated an increase in cancer-related deaths due to delays in mammographic diagnosis. Additionally, it is believed that women with implants tend to be more health-conscious and better informed about breast cancer screening practices. The study involved 292 women participants, with 91% aged between 40 and 49 years, and 94% being 50 years or older. For women aged 40 to 49 who have breast implants, the likelihood of having had at least one mammogram increased by around 28%. Similarly, a 27% rise was noted among women aged 50 to 69.

4.28- ANN POULOUS (2003): Breast Compression in mammography: How much is enough?

In mammography, breast compression is utilized to decrease breast thickness, lower radiation exposure, and enhance image quality. This study sought to investigate the relationship among the compression force applied, breast thickness, levels of pain or discomfort, and the quality of the

images produced. Conducted as an experimental study, it analyzed variations in breast thickness and image quality associated with different levels of compression force, all measured on the same breast and mammographic projection. The study focused on compressed breast thickness, which is influenced by age and the proportion of fatty tissue, with these factors being interrelated. The sample consisted of 114 participants with an average age of 60 years. Each participant underwent an additional craniocaudal film, which involved reducing the compression force by 10, 20, and 30N compared to the standard procedure. Compression forces were recorded between 40 and 100N using a digital readout. The results of the study indicated that there was no linear relationship between the compression force applied and the resulting breast thickness, nor was there any connection between the degree of compression and the discomfort reported by participants. Larger breasts necessitated greater compression force than smaller ones. Women who indicated experiencing severe discomfort also had a higher mean compressed thickness. These results highlighted that breast weight is associated with the level of discomfort experienced.

4.29- R. GUPTA (2002): Pain during Mammography: Impact of Breast Pathologies and Demographic Factors

This study sought to systematically evaluate the pain experienced by patients undergoing mammography for various clinical indications. It involved 225 participants aged between 25 and 85 years, with a mean age of 45.43 ± 8.25 years, who were referred for mammography. The presenting symptoms and clinical diagnoses were provided by the referring healthcare providers, while demographic data were collected through self-reported questionnaires. The radiologist documented the mammography findings. Pain levels during the procedure were assessed using two validated measures: Visual Analog Scale (VAS) and the Pain/Discomfort Rating Scale (DRS). The gathered data were statistically analyzed to identify potential predictors of pain. According to the VAS, 49% of participants reported experiencing pain when the cutoff was set at 40. However, this figure dropped to 23% when the threshold was increased to 60, considering that some patients had preexisting pain as a presenting symptom. On the DRS, 7% of individuals reported pain, 27% indicated discomfort, and 66% noted neither. Patients with coexisting breast lumps, prior breast pain, or those diagnosed with inflammatory breast issues and fibrocystic

changes reported higher levels of pain during mammography. Furthermore, demographic factors such as age and educational background significantly affected pain reporting. This highlights the necessity of thorough pain assessment using standardized tools and understanding the relationship between pain and various breast conditions, which is essential for devising effective pain management strategies for women undergoing mammography.

3.30- B. HAFSLUND (2000): Mammography and the experience of Pain and Anxiety

The objective of this study was to evaluate the pain and anxiety levels experienced by women during mammography and to investigate how radiographers can improve the overall experience for patients undergoing this X-ray procedure. The research involved 170 women aged between 40 and 69 years, using structured questionnaires that included the McGill Pain Questionnaire, the State-Trait Anxiety Inventory (STAI), and a Questionnaire for Predictor Variables. During the mammography sessions, 66.5% of participants reported feeling pain, although most characterized it as mild to moderate. A significant relationship was observed between anxiety and pain experienced after the procedure ($P<0.01$). While the study highlighted that both anxiety and pain associated with mammography were genuine experiences, the majority of women did not view them as significant concerns.

CHAPTER-5

MATERIALS AND METHODS

1. PLACE OF STUDY

This study is conducted at Ghaziabad (Delhi NCR).

2. PERIOD OF STUDY

The study was conducted over one year, starting in September 2023 and concluding in August 2024.

3. STUDY DESIGN

A questionnaire-based cross-sectional study, was conducted at the Radiology department for the assessment of the level of Pain due to mammographic compression, and data was collected by direct interview and general discussion.

4. STUDY SUBJECTS

The main subject of this study is Mammography Patients who have undergone mammography procedures during their screening and treatment phase.

4.1. Inclusion criteria

- The patient who has undergone the mammographic procedure.
- The mammographic Technologist who interviewed the participants was part of this study.

4.2. Exclusion criteria

- Other health professionals and medical imaging/radiology technologists who have not contributed in any way will not be part of the study.
- The patients who have neurological disorders and other severe somatic or psychiatric diseases and also who did not give their consent in any form.
- The patients who have any breast implants.
- The patient does not give their consent.

5. Sample Size Calculation

The study includes 270 participants in mammography. Sample size (n) for various confidence levels.

Confidence-level (%)	Sample size
95%	270
80%	116
90%	190
97%	331
99%	466
99.9%	760
99.99%	1062

The sample size formula used is as follows:

Sample size (n) = [DEFF*Np (1-p)]/[(d2/Z21-α/2*(N-1)+p*(1-p)]

Where=sample size

DEFF=design effect

N=population size

P= The estimated proportion

q=1-p

d=desired absolute precision or absolute level of precision

With the anticipated frequency of 22.7% and the confidence limit of %+/-5, here in this study the 95% confidence level is used.

6. Study Variables

6.1. Independent Variables: Age, Gender, Marital status, Education, Profession, Smoking, consuming Chocolates, drinking Tea/Coffee, taking Pain relievers whenever Pain Persists, Being in Menopause, Previous Breast Examination, Ratings for communication and support, receiving information before Mammogram, allowing communication of any pain/discomfort, satisfaction with the duration, and effort in minimizing pain.

6.2. Dependent Variable: Pain/Discomfort, Location of Discomfort or Pain, Pain intensity, Effect of findings.

7. Data Collection Procedure: In this study, we employed a Simple Random Sample to collect the data from the population sample.

7.1. Data Collection Method:

Throughout the study period, radiographers provided assistance and conducted interviews with all participants. Those who consented to take part were given a questionnaire that focused on the pain they experienced during their mammography. This questionnaire was filled out right after the examination. By completing the questionnaire, participants provided informed consent, granting permission for their data to be utilized in this research.

7.2. Data Collection Tool

The following tools were used to collect data.

A) The study tool used here is questionnaire which consists of three sections.

Section-A

i) The structured interview with the women was divided into three sections. The first section collected socio-demographic information, which the women completed themselves. This section included nine items: (1) age, (2) gender, (3) marital status, (4) educational level, (5) occupation, (6) things which are consumed like smoking /having tea or coffee/consuming, chocolates, pain relieving, medicines, (7) menstruation status, (8) number of prior mammograms, and (9) level of Pain experienced during mammography.

ii) The second part includes questions related to the technician's prior mammographic knowledge, preparation, experience, and duration of the mammographic procedure, which help assess the participants' ratings of the Technologist.

iii) The third part of the questionnaire was completed after reviewing the report of the Mammogram of that particular participant to observe the influence of the findings on the perceived pain.

Section-B The pain level was measured using a pain scale. There were 10 levels of Pain – No Pain, Discomforting, Tolerable, Distressing, Very Distressing, Intense, Very Intense, Horrible, Excruciating, and Unimaginable that required compression for measurement.

Section-C Anxiety and Emotional Distress Scale. In this scale the participants were asked questions about their feelings and thoughts during the Mammogram, and they answered YES and NO.

8. Ethical Clearance

Ethical approval of F. No. SU/R/2024/1344(46) was obtained on 17.05.2024 by the Ethical Committee of Santosh Deemed to be University, Ghaziabad Delhi NCR.

9. Statistical Analysis

Data were entered into MS Excel 2019 and analyzed using Stata17.0. Categorical variables were presented as frequencies and percentages. As appropriate, associations were assessed using Fisher's Exact Probability Test or χ^2 test, with statistical significance set at $P < 0.05$ at the two-sided test.

CHAPTER-6

RESULT

This study consists of 263 (97.41%) females and 7 (2.59%) males as shown in table 1, from a total of 270 participants with ages 22 to 75. Graph 1 shows that the number of male participants is very few compared to females.

Table 1- shows gender distribution.

Gender	Number	%
Male	7	2.59
Female	263	97.41

Graph 1- gender distribution.

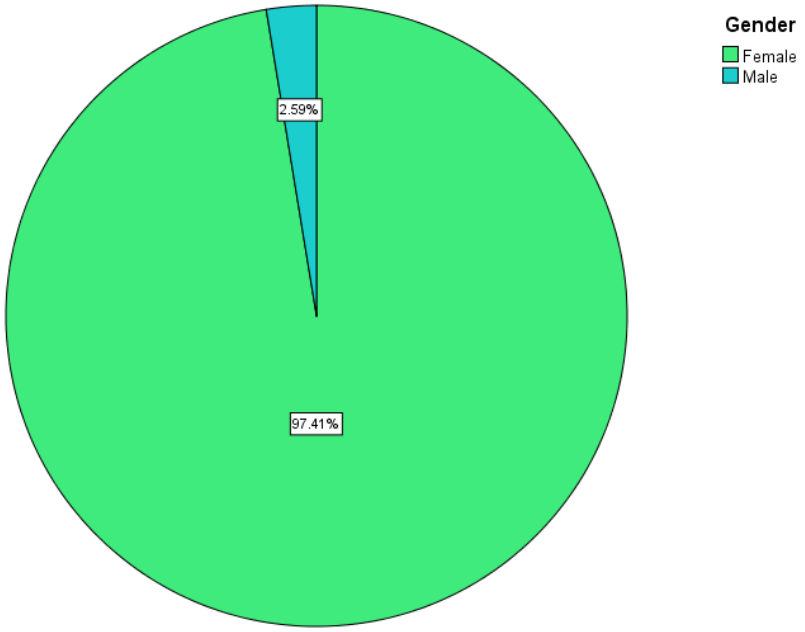


Table 2. Shows the descriptive background characteristics of the mammography participants. The majority of the participants (90.7%) were married, most of them had a university level of education (52.6%), and less than half (17.4%) of them were those who had an elementary level of education or were able to read and write only. More than half of this study's participants (53.7%) were salaried employees, and a few were students (1.1%).

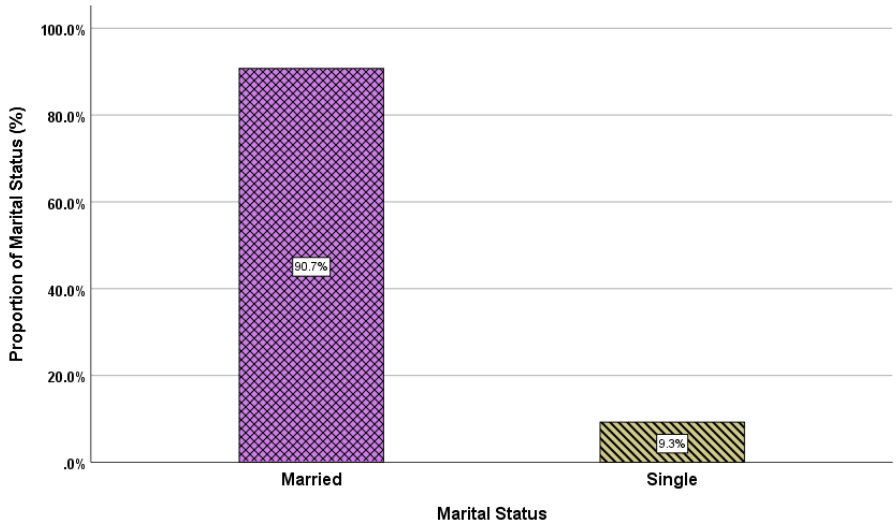
In this study health behaviour of the participants was also observed, in which we found about (19.6%) were active smokers with maximum male indulgence. This has a direct effect on their pain experience; nonsmoking participants have more pain/discomfort tolerance power than smokers. A few of them consume chocolates (35.3%), The chocolate-eating routine had also significantly increased discomfort intolerance scores of women. Most of the participants (94.8%) were addicted to drinking tea/coffee. About 19.6% of participants were taking pain relievers whenever Pain persisted in their breast or area around it, and these were more intolerable to pain/discomfort.

Of the total 253 female participants, less than half, 115(42.6%), were being menopause and due to the hormonal imbalance it directly affects their breast density. Most of the participants were having their first Mammogram, and about 20 (7.4%) were experienced, with 95.5% feeling some pain/discomfort during their mammography; this also shows the effect of knowledge and experience of their prior Mammogram. More than half, 209(77.4%) of the participants have come with the complaint of breast pain, and 37(14.1%) were showing the axilla as their location of Pain and maximum of them showed a high level of pain/discomfort.

Table 2- Showing descriptive features of the participants.

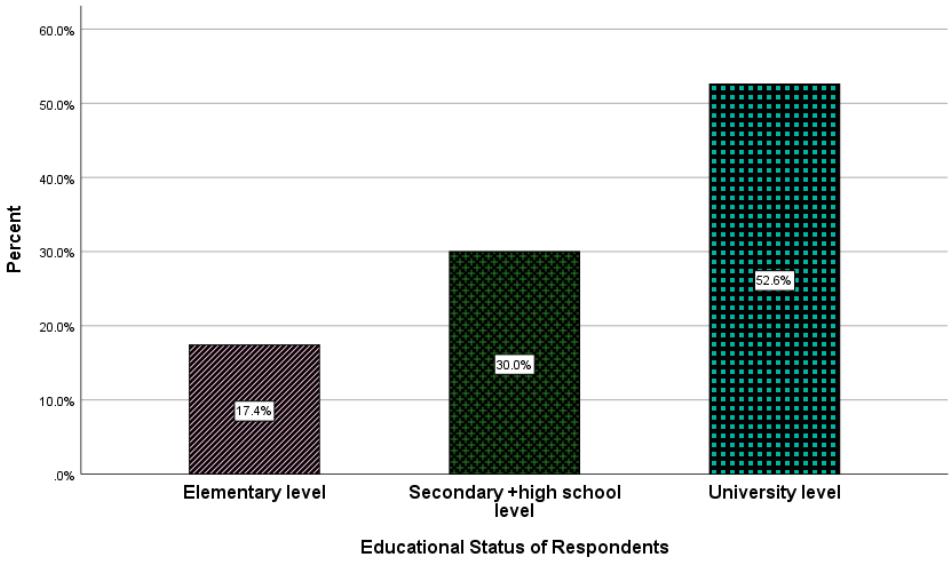
Background Characteristics of the Study Participants	Number	%
Marital Status		
Single	25	9.3
Married	245	90.7
Educational Status		
Elementary level	47	17.4
Secondary +High school level	81	30.0
University level	142	52.6
Profession		
Housewife	114	42.2
Salaried employee	145	53.7
Retired	8	3.0
Student	3	1.1
Health Behaviors		
Smoking		
Yes	53	19.6
No	217	80.4
Consuming chocolates		
Yes	95	35.2
No	175	64.8
Drinking Tea/Coffee		
Yes	256	94.8
No	14	5.2
Taking pain relievers whenever Pain persists		
Yes	53	19.6
No	217	80.4
Being Menopause (n=253,only women)		
Yes	115	42.6
No	148	54.8
Previous Breast examination		
Yes	20	7.4
No	250	92.6
Pain/Discomfort during Mammography		
Yes	258	95.5
No	12	4.4
Location of Pain Persist		
Breast	209	77.4
Armpit	38	14.1
Both breast and armpit	16	5.9
Chest	7	2.6

Graph-2: Bar graph showing the proportion of marital status percentage.



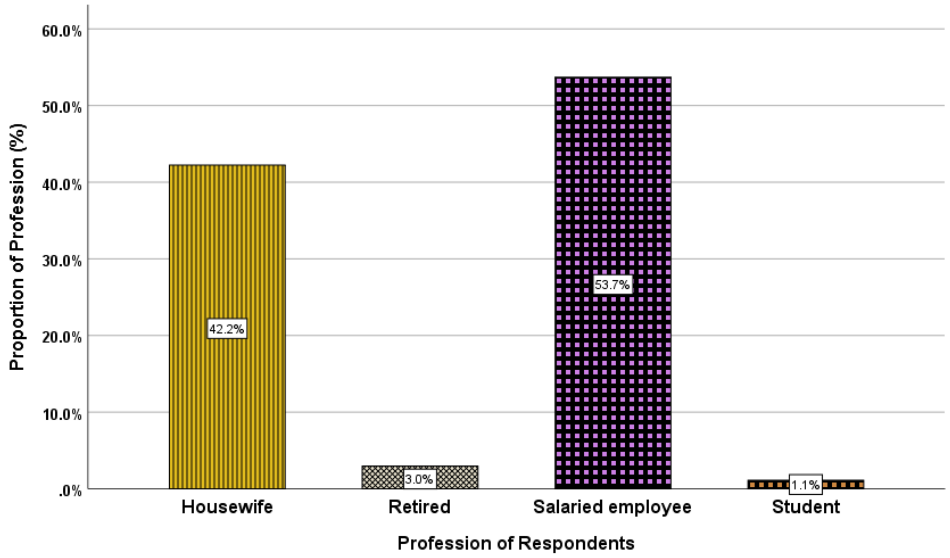
Graph 2 This simple bar graph shows that most participants were married. Change in breast anatomy is a sign of aging but these changes can also occur at an early age, so here a few were young and single.

Graph-3: Bar graph showing the participants' distribution according to their education level.



Graph 3 shows that education level seems to affect knowledge and awareness of some dimensions. This study consists of about 52.6% of participants who graduated at the university level and were the most knowledgeable and aware of the procedure performed and also about the signs and symptoms of breast cancer.

Graph 4: The bar graph shows the distribution of participants according to their profession.



Graph 4 shows the proportional distribution of all the participants according to their profession or job. More than half of the participants were salaried employees, about 42.2% were homemakers, and a few were retired and students. This variable does not directly show any effect on the level of pain/discomfort they have experienced, but the profession affects their personality and attitude towards the level of Pain and discomfort.

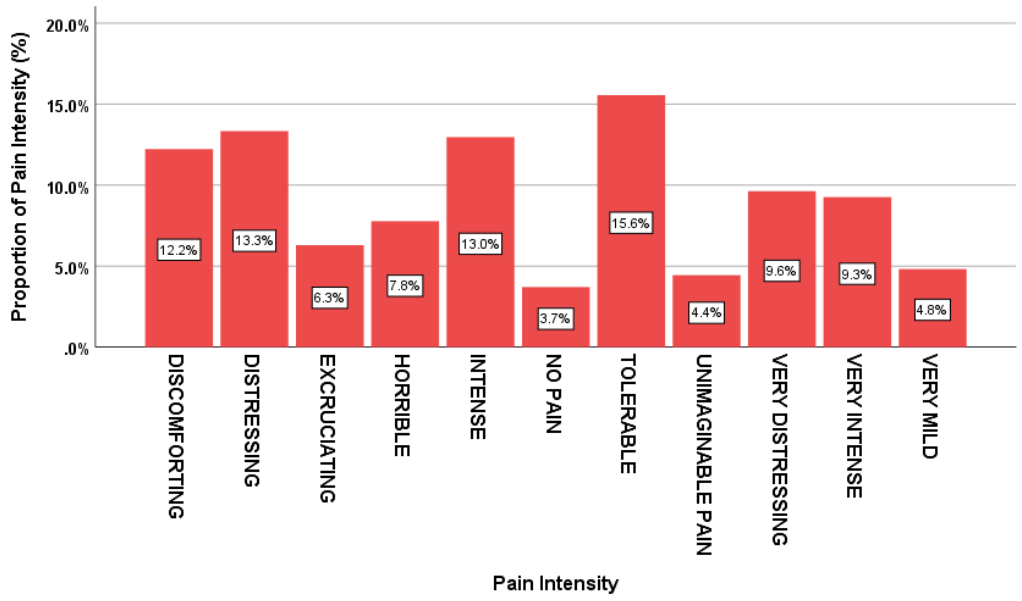
This study analysed the pain intensity using a Visual Analog Scale from No Pain to Unimaginable Pain. No pain was demonstrated during the examination with no pain & discomfort, and unimaginable Pain was the highest pain intensity level. These pain characteristics are shown in Table 3- In this study, we have considered only male and female participants, with the males being the few in number, and a maximum of them experienced unimaginable Pain.

Table 3- Evaluate the level of pain intensity based on both genders.

Variables	**Gender**		χ^2	**P-value**
Pain Intensity	**Female N (%)**	**Male N (%)**		
Discomforting	33 (100)	0 (0)	40.710	<0.001
Distressing	36 (100)	0 (0)		
Excruciating	16 (94.1)	1 (5.9)		
Horrible	21 (100)	0 (0)		
Intense	35 (100)	0(0)		
No Pain	10 (100)	0 (0)		
Tolerable	42 (100)	0 (0)		
Unimaginable Pain	6 (50.0)	6 (50.0)		
Very Distressing	26 (100)	0 (0)		
Very Intense	25 (100)	0 (0)		
Very Mild	13 (100)	0 (0)		

The maximum number of participants had tolerable pain; 42(100%) and 10(100%) did not have any Pain, and all of them were females. From both genders, 36(100%) had distressing levels of Pain, and 35(100%) were complaining of intense levels of Pain. Unimaginable pain intensity was seen in equal proportion in both genders: 6(50%). 13(100%) reported very mild Pain.

Graph 5- shows the distribution of participants on the basis of Pain Intensity.



The graph-5 represents the maximum (15.6%) number of participants were had tolerable levels of Pain with the minimum (3.7%) of the no-pain population. An unimaginable pain level was seen in (4.4%) of the population.

Table 4- shows the level of pain intensity in different age groups.

Variables	Age Groups				χ^2	P-value
Pain Intensity	**20 - 40 N (%)**	**40 – 49 N (%)**	**49 - 69 N (%)**	**>69 & above**		
Discomforting	21 (63.6)	6 (18.2)	6 (18.2)	0 (0.0)	92.268	91.000
Distressing	10 (27.8)	15 (41.7)	11 (30.6)	0 (0.0)		
Excruciating	3 (17.6)	2 (11.8)	9 (52.9)	3 (17.6)		
Horrible	1 (4.8)	7 (33.3)	10 (47.6)	3 (14.3)		
Intense	7 (20.0)	15 (42.9)	11 (31.4)	2 (5.7)		
No Pain	8 (80.0)	2 (20.0)	0 (00.0)	0 (0.0)		
Tolerable	15 (35.7)	20 (47.6)	7 (16.7)	0 (0.0)		
Unimaginable Pain	3 (25.0)	3 (25.0)	3 (25.0)	3 (25.0)		
Very Distressing	8 (30.8)	4 (15.4)	14 (53.8)	1 (4.0)		
Very Intense	4 (16.0)	6 (24.0)	14 (56.0)	1 (4.0)		
Very Mild	5 (38.5)	5 (38.5)	3 (23.1)	0 (0.0)		

Table 4- shows the level of intensity of Pain according to different age groups. These age groups were formed on the basis of changes that occur in breast anatomy with respect to age. In this study, there are four age groups- 20 to 40, 40 to 49, 49 to 69, and above. The maximum number of participants were of the age group of 49 to 69 and the minimum were from the 69 and above as shown in graph-6.

From the age group 20 – 40, a maximum of 21 patients (63.6%) had a Discomforting level of Pain, and only 1(4.8%) complained of horrible Pain. From the age group, 40 – 49 maximum participants felt a Tolerable amount of pain intensity, and very few showed No Pain 2(20%). Also, there was an equal ratio of 15(42%) of Distressing and Intense pain seen. In the age group 49 – 69 maximum number of participants were complaining of Very Distressing 14(53.8%)and Very Intense 14(56%) level, and also there was an equal ratio for Distressing 11(30.6%) and Intense 11(31.4%) level of pain intensity. None of the patients was seen with No pain or Discomfort in this age group. In the age group of 69 and above, most patients were seen with the complaint of Distressing 3(17.6%), Excruciating 3(14.3%) and Unimaginable 3(25%) level of pain.

Graph 6- Shows the graphical representation of the respondent according to their age groups.

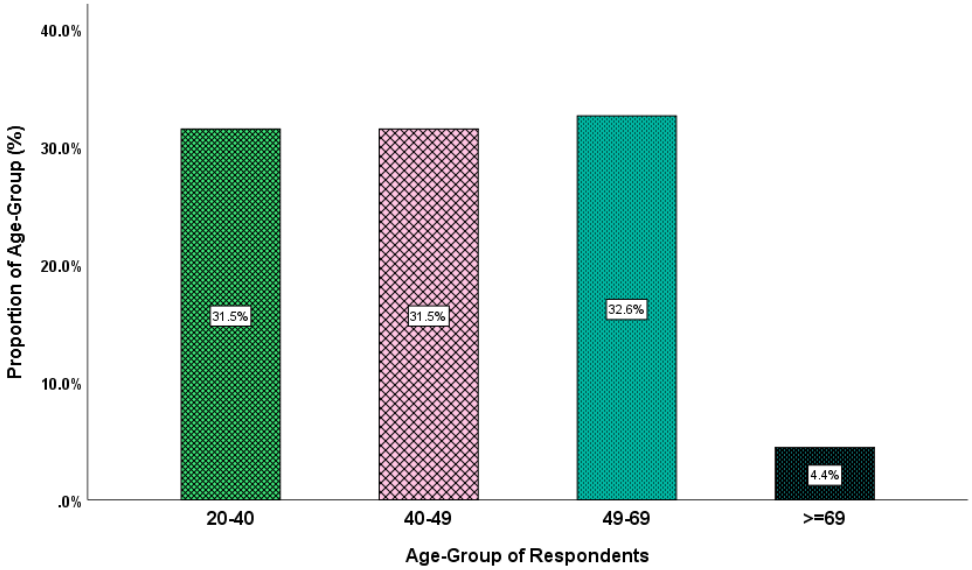


Table 5- demonstrate the different intensity of pain levels, experienced with different breast pathologic findings. The mammographic findings in this study were as follows- Normal, Inflammatory Diseases, Fibroadenoma, Fibrocystic changes, Calcification, Malignant lesion, and Suspected Malignancy. Of the total participants, more than half had normal findings. In the case of normal findings 8(80%) participants did not feel any Pain, with a maximum of 33(78.6%) of them feeling Tolerable and 32(90%) feeling only discomforting level. High pain intensity ratio was low 9(75%) in this case.

Table 5- Shows the level of pain intensity according to their findings.

Variables	Findings							χ^2	P-value
Pain Intensity	**Inflammatory Diseased N(%)**	**Malignant Lesion N (%)**	**Suspected Malignant N (%)**	**Calcification N (%)**	**Fibro-adenoma N (%)**	**Fibrocystic changes N (%)**	**Normal N (%)**		
Discomforting	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.0)	0 (0.0)	32 (97.0)	93.394	99.202
Distressing	7 (19.4)	1 (2.8)	0 (0.0)	3 (8.3)	6 (16.7)	4 (11.1)	15 (41.7)		
Excruciating	2 (11.8)	2 (11.8)	1 (5.9)	0 (0.0)	0 (0.0)	2 (11.8)	10 (58.8)		
Horrible	3 (14.3)	1 (4.8)	2 (5.7)	1 (4.8)	2 (9.5)	0 (0.0)	14 (66.7)		
Intense	5 (14.3)	1 (2.9)	2 (5.7)	2 (5.7)	3 (8.6)	3 (8.6)	19 (54.3)		
No Pain	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (20.0)	0 (0.0)	8 (80.0)		
Tolerable	1 (2.40	0 (0.0)	0 (0.0)	0 (0.0)	7 (16.7)	1 (2.4)	33 (78.6)		
Unimaginable	1 (8.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (16.7)	9 (75.0)		
Very Distressing	2 (7.7)	1 (3.8)	0 (0.0)	0 (0.0)	4 (15.4)	3 (11.5)	16 (61.5)		
Very Intense	1 (4.0)	1 (4.0)	4 (16.0)	0 (0.0)	1 (4.0)	0 (0.0)	18 (72.0)		
Very Mild	1 (7.7)	0 (0.0)	0 (0.0)	0 (0.0)	2 (15.4)	1 (7.7)	9 (69.2)		

From the findings of Inflammatory diseases maximum of 7(19.4%) patients complain of a Distressing level of pain intensity. Some 5(14.3%) complain of an Intense level of Pain, and also a few 1(7.7%) seem to have a mild level of Pain. In the case of calcification highest level of pain intensity seen was 3(8.3%), and the lowest was Horrible 1(4.8%). In the case of Fibroadenoma, maximum participants feel a Tolerable level of Pain while some complain of a Distressing level of pain intensity 6(16%). In Fibrocystic changes, a maximum of participants, 4(11.1%) were complaining of Distressing Pain, and 1(7.7%) also felt Very Mild Pain. The patients with Malignant lesion findings probably feel higher Pain than other patients, the maximum level of Pain they complain about is Excruciating 2(11.8%), some complain of Very Distressing 1(3.8%),

and Very Intense 1 (4%). In the case of Suspected Malignancy,a maximum number of patients feel Very Intense pain 4(16%), and 1(5.9%) of them complain of Excruciating pain intensity.

Table 6- shows the Effect of the level of Pain Intensity on Anxiety and Emotional Distress.

Variables	Anxiety and Emotional Distress		χ^2	P-value
Pain Intensity	**Yes N (%)**	**No N (%)**		
Discomforting	1 (3.0)	32 (97.0)	154.084	172.707
Distressing	33 (91.7)	3 (8.3)		
Excruciating	17 (100.0)	0 (0.0)		
Horrible	21 (100)	0 (0)		
Intense	32 (91.4)	3 (8.6)		
No Pain	1 (10.0)	9 (90.0)		
Tolerable	22 (52.4)	20 (47.6)		
Unimaginable Pain	8 (66.7)	4 (33.3)		
Very Distressing	24 (92.3)	2 (7.7)		
Very Intense	24 (96.0)	1 (4.0)		
Very Mild	2 (15.4)	11 (84.6)		

Table 6- shows the effect of the intensity of Pain on the emotional distress and anxiety of the participants after their Mammogram.

The direct effect has been seen in more than half of the patients, and about 85(31.4%) do not show any anxiety or emotional distress after the procedure. In the case of anxious participants, a maximum of 33(91.7%) of them complained about a Distressing level of Pain and still felt only Discomfort 1(3%) and No Pain 1(10%). In the case of participants with no Anxiety and Emotional distress, a maximum of 32(97%) feel a discomfort level of pain intensity, with only 1(4%) of them having a Very Intense level of Pain.

Table 7- shows the distribution of the participants according to their level of Education and its effect on the Intensity of Pain experienced.

Variables	Educational Level			χ^2	P-value
Pain Intensity	**Elementary N (%)**	**Secondary+ High School N (%)**	**University N (%)**		
Discomforting	2 (6.1)	5 (15.2)	26(78.8)	58.147	59.671
Distressing	3 (8.3)	11 (30.6)	22 (61.1)		
Excruciating	7 (41.2)	7 (41.2)	3 (17.6)		
Horrible	8 (38.1)	7 (33.3)	6 (28.6)		
Intense	6 (17.1)	12 (34.3)	17 (48.6)		
No Pain	1 (10.0)	1 (10.0)	8 (80.0)		
Tolerable	4 (9.5)	7 (16.7)	31 (73.8)		
Unimaginable Pain	2 (16.7)	3 (25.0)	7 (58.3)		
Very Distressing	7 (26.9)	9 (34.6)	10 (38.5)		
Very Intense	6 (24.0)	15 (60.0)	4 (16.0)		
Very Mild	1 (7.7)	4 (30.8)	8 (61.5)		

Table 7- Demonstrate the distribution of participants according to their level of education and its effect on the intensity of Pain experienced. In this study, we consider three levels of education, these are Elementary, Secondary+high school, and University level. From an elementary level of education, the maximum number of participants, 8(38.1%), complained of a Horrible level of Pain, and only a few with Mild 1(7.7%) or No Pain 1(10%). Maximum participants from secondary+high school level complained of Very Intense 15(60%) levels of Pain, a few 3925%) with Unimaginable Pain, and in University level educated participants, a maximum of 31(73.8%) of them were having Tolerable levels of pain intensity and few 3(17.6%) with Excruciating level of Pain.

Table 8- shows the differentiation of participants based on profession.

Variables	Profession				χ^2	P-value
Pain Intensity	**Housewife N(%)**	**Salaried Employed N (%)**	**Retired N (%)**	**Student N (%)**		
Discomforting	7 (21.2)	23 (69.7)	1 (3.0)	2 (6.1)	61.347	56.137
Distressing	15 (41.7)	20 (55.6)	1 (2.8)	0 (0.0)		
Excruciating	11 (64.7)	6 (35.5)	0 (0.0)	0 (0.0)		
Horrible	14 (66.7)	6 (35.3)	0 (0)	0 (0.0)		
Intense	19(54.3)	15 (42.9)	1 (2.9)	0 (0.0)		
No Pain	2 (20.0)	8 (80.0)	0 (0.0)	0 (0.0)		
Tolerable	10 (23.8)	31 (73.8)	1 (2.4)	0 (0.0)		
Unimaginable Pain	2 (16.7)	7 (58.3)	2 (16.7)	1 (8.3)		
Very Distressing	15 (57.7)	11 (42.3)	0 (0.0)	0 (0.0)		
Very Intense	16 (64.8)	8 (32.0)	1 (4.0)	0 (0.0)		
Very Mild	3 (23.1)	10 (76.9)	0 (0.0)	0 (0.0)		

Table 8- shows the differentiation of participants based on their professions these are Housewife, Salaried employee, Retired, and Student. Among the housewife, a maximum of 19(%) of them complain of an Intense level of Pain and very few 2(20%) have no pain. Among salaried employees,a maximum of 31(73.8%) of them feel a tolerable level of Pain and the minimum pain they have complained about is Excruciating 6(35.5%) and Horrible 6(35.3%). Maximum of the Retired participants shows Unimaginable pain 2(16.7%), some complains Very Intense 1(4%), Intense 1(2.8%), Distressing 1(2.8%), Discomforting 1(3%). Maximum of students, 2(6.1%) conform to a Discomforting level of pain intensity, with 1(8.3%) experiencing Unimaginable Pain.

Table 9- shows the experience of Pain/Discomfort with respect to the gender of the participants.

Variable	PAIN/DISCOMFORT		χ^2	P-value
Gender	Yes N (%)	No N (%)		
Male	7 (100)	0 (0)	0.334	0.645
Female	251 (95.4)	12 (4.6)		

Table 9- demonstrates the unpleasantness experienced by the participants on the basis of their gender. All the male 7(100%) participants complained of pain/discomfort. Among female participants, more than half, 251(95.4%) of them complained of pain/discomfort, and 12(4.6%) were having some Pain. As graphy-7 representing from the total, there were 95.6% of participants had complaints of pain/discomfort, and only 4.4% did not have any kind of unpleasantness.

Graph 7- distribution of participants on the basis of the experience of pain/Discomfort.

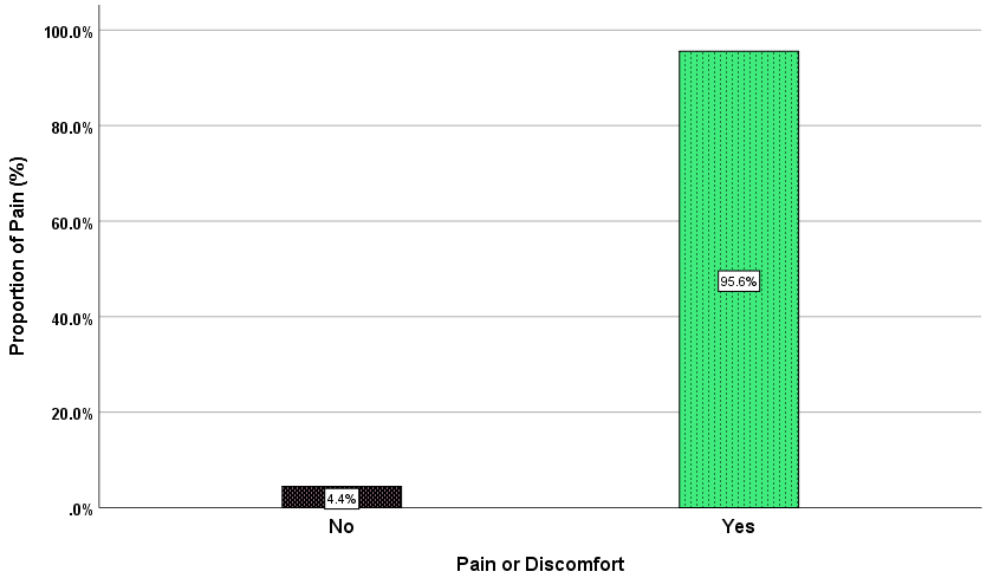


Table 10- showing the effect of Pain/Discomfort on Anxiety and Emotional distress.

Variable	Pain/Discomfort		χ^2	P-value
Anxiety and Emotional Distress	Yes N (%)	No N (%)		
Yes	184 (71.3)	1 (8.3)	21.088	20.252
No	74 (28.7)	11 (91.7)		

Table 10- demonstrates the pain/discomfort experienced during mammography has a direct effect on Anxiety and Emotional distress after the completion of the procedure. In this study, more than half of the patients, 184(71.3%) experiencing pain/discomfort, have a positive effect on Anxiety and emotional distress, and 74(28.7) do not have Anxiety, but they experience pain/discomfort. There were 11(91.7%) who neither experience pain nor had Anxiety, but there were 1(8.3%) who did not experience pain/discomfort but had some Anxiety.

Table 11- shows the effect of Education on the experience of Pain/Discomfort.

Variable	Pain/Discomfort		χ^2	P-value
Education	Yes N (%)	No N (%)		
Elementary Level	46 (17.8)	1 (8.3)	2.537	2.677
Secondary + High school Level	79 (30.6)	2 (16.7)		
University Level	133 (51.6)	9 (75.0)		

The maximum participants in this study were university-level graduates, of which 133(51.6%) gave a positive response for experiencing pain/discomfort, as shown in Table 11- and 9(75%) does not feel any pain/Discomfort. 79(30.6%) participants form Secondary+highschool level of education report unpleasentness and 2(16.7%) of them does not have any pain/discomfort 46(17.8%) of participants from the Elementary level experience pain/discomfort, and 1(8.3%) do not feel any pain/discomfort.

Table 12- shows the experience of Pain and Discomfort based on Profession

Variables	Pain/Discomfort		χ^2	P-value
Profession	**Yes N (%)**	**NO N (%)**		
Housewife	112 (43.4)	2 (16.7)	4.507	5.269
Retired	8 (3.1)	0 (0.0)		
Salaried Employee	135 (52.3)	10 (83.3)		
Student	3 (1.2)	0 (0.0)		

Table 12- Shows 135(52.3%) Salaried employee participants experienced Pain/Discomfort. 112(43.4%) of housewives reported pain/discomfort and minimal amount was found in Students 3(1.2%) and 8(3.1%) was found in retired participants.

Table 13- shows the responses to the questions asked after the mammography procedure.

Variables	Category	
Questions asked to Rate the Technologist	Yes N (%)	No N(%)
Information Receive Before Mammogram	254 (94.1)	16 (5.9)
Allow to Communicate any Discomfort/Pain	243 (90.0)	27 (10)
Satisfied with the Duration	256 (94.8)	14 (5.2)
Effort to Minimize Discomfort/Pain	241 (89.3)	29 (10.7)
Anxiety or Emotional Distress	185 (68.5)	85 (31.5)

Table 13- consists of questions which the participants asked after the completion of the procedure to observe their experiences and ratings for the technologist. In this study, 254(94.1%) participants agreed that they received information about the procedure before their examination, but 16(5.95) denied. 256(94.8%) were satisfied with the duration of their, 241(89.3%) were agreed that their technologist made an effort to minimize their pain/discomfort, 185(68.5%) experiences Anxiety and emotional distress after the procedure and 85(31.5%) does not have any anxiety.

CHAPTER-7

DISCUSSION

Mammography serves as an efficient approach for routine breast cancer screening and the early diagnosis of the disease. It is not only one of the most advanced imaging techniques available, but also widely preferred due to its affordability, ease of use, and accessibility. The present study aimed to evaluate the levels of pain and anxiety experienced by women undergoing mammography and to explore whether prior knowledge of the procedure influences these pain and anxiety levels.

There are no screening guidelines for men, even for those who are at high risk of developing breast cancer. The American College of Radiology Appropriateness Criteria Committee recently recommends mammography or DBT in men, aged 25 and above, if there are symptoms of breast cancer or the physical examination is suspicious. In this study, we have also included male patients, but the proportion is very low as compared to female patients, with the maximum being normal.

Breast cancer also increases with age, with over 80% of cases occurring in women older than 50 years. The aging process initiates a series of changes in breast anatomy; it includes an increase in fatty tissues and a decrease in breast density, which can later promote the occurrence of breast cancer. This study consists of four groups of participants according to age distribution. The majority of them were between the ages of 49 and 69, which clearly shows the effect of change in breast anatomy on the age of participants. Marital status does not have any effect on the experience of Pain and discomfort.

Güçlü S et al. identified the most significant barriers to obtaining screening mammography. According to their findings, 99.2% of women cited a lack of information about breast cancer and a low level of education as the primary obstacles. This study contradicts Aldhafeeri et al.; the barriers to the implementation of mammogram procedures in women are often linked to a lack of knowledge about these methods. Factors such as low levels of education and inadequate information about mammogram screenings and breast cancer symptoms can lead to delayed diagnoses. The current study has been conducted in urban areas, and most of the participants

have a university level of education, so most of them have knowledge about the procedure as well as the symptoms of breast cancer. Their education level shows a positive impact on their interaction with Radiology technologists and the knowledge/explanation about the procedure they have shared before the Mammogram.

A study indicated that variables such as age, education, breast size, family history of breast cancer among first-degree relatives, menopause status, and coffee intake did not influence the pain or discomfort experienced during mammography. In this study, which included both experimental and control groups, the severity of pain reported was 3.5 for the group that received paracetamol, whereas the placebo group reported a pain level of 2.9. Additionally, the current research suggests that participants using pain relievers demonstrated lower pain tolerance compared to those who did not use them. Furthermore, active smokers appeared to have a lower tolerance for pain in comparison to non-smokers.

A study found that women who experienced mild to severe pain (NRS 3-8) had greater compressed breast thickness than those who reported no pain (NRS 0-2). This compressed breast thickness can be influenced by factors such as breast volume, the amount of compression force applied, and the compressibility of the tissue. Fatty tissues are more compressible than fibroglandular tissue, which means women with less compressible breasts may experience more pain. Our findings align with this observation, particularly noting that men, who also have less compressible breast tissue, report higher pain levels compared to women. In women, a direct relationship exists between increased pain intensity and thicker breasts under compression; those with thicker breasts tend to report more pain than their thinner counterparts. This variation underscores the individual differences in pain tolerance, as each person's response to pain is unique. The study also indicated that women experienced heightened levels of pain and anxiety during mammography of the breast with an Implantable Medical Device (IMD). However, it is noteworthy that overall pain scores remained low, and while the difference in pain between the two breasts was statistically significant, was minimal. This could be due to the reduced compression force applied to the breast with the IMD, which may have alleviated some of the discomfort associated with the device's presence. The current study also supports the study of jeujen in which he states the applied force must be adjusted according to the individual breast contact area. In other words, the compression is customized, as smaller breasts will achieve the target pressure with less force compared to larger breasts.

From the previous study findings, Pain and unpleasantness ratings during mammography were higher compared to both pre-and post-screening. While post-mammography pain returned to its initial level, the feeling of unpleasantness remained elevated, indicating a lingering sense of discomfort or displeasure even after the screening was completed. Among the personality traits studied, psychoticism was the one we least expected to have an impact, but it shows a significant role in how individuals experienced or reacted. However, this study found that psychoticism was linked to higher feelings of unpleasantness or discomfort during mammography.

Keemers et al reported that Pain during mammogram exams can deter some women from attending future screening. Reducing Pain is important to encourage regular mammography and improve the overall experience. Women who have had prior breast procedures may feel more Pain during mammograms, especially as repeated compression is often needed for clear imaging. Breast cancer survivors, who commonly experience ongoing breast pain, may also feel more discomfort during mammograms, with 88% reporting pain. Minimizing these pain risks is key to ensuring women continue with their screenings.

A significant amount of unnecessary anxiety occurs because of a lack of adequate information. Providing clear details about upcoming procedures and a timeline for when to expect results can help reduce this stress and offer reassurance. This study supports Jackson et al., who states that effective communication and clear information are essential in reducing anxiety. By providing detailed explanations about procedures and setting clear expectations for results, unnecessary stress can be significantly minimized.

The time between an abnormal screening and a definitive diagnosis can cause significant anxiety and distress for women, often lasting for months. For those diagnosed with cancer, this initial distress may undermine their trust and confidence in the healthcare system. For others, it may discourage them from attending future screenings. It should be noted that the positioning of the breast is also a critical factor, as it can significantly influence the distribution of compression and the associated pain experience.

CHAPTER- 8

CONCLUSION

The research suggests that the mammography compression process is a blend of both artistic and scientific elements. The ability to tolerate discomfort reflects how well individuals can endure conditions that disrupt comfort. Women who do not take pain relievers and those who are non-smokers tend to have a higher tolerance for discomfort. Pain can also be decreased with the help of the flexible compression paddle, as it provides a better experience in terms of pain during mammography compared to the fixed paddle. This also suggests two possible strategies for preventing Pain: implementing a personalized compression protocol that applies the same target pressure to all breasts at a consistent, slow rate and reducing the duration of the breast clamping phase. Women with a history of breast masses and abnormal test results were less likely to avoid discomfort compared to those who underwent regular mammogram checkups. The experience and specialization of the practitioner play a key role in determining the right balance between compression and technical accuracy. This balance is crucial for ensuring patient comfort while achieving optimal imaging results for accurate diagnosis.

CHAPTER – 9

FINDINGS AND RECOMMENDATIONS

1. There is a need for research on pain and anxiety during radiographic examinations, it seems to be a crucial focus area for radiographers. Many studies suggest that healthcare personnel have insufficient knowledge about pain and its various individual aspects.

2. In our study, many practitioners do not routinely use objective measures, such as compression force and thickness values from mammography machines, to guide optimal compression force selection. To reduce the subjectivity in applying compression, the focus should be on internal breast pressure rather than external force. However, the lack of engagement suggests a culture shift may be needed to adopt these "pressure-controlled mammography protocols".

3. We are unable to determine which one of the four mammographic views in the study was reported to be more painful for the women and also which type of paddle produces more pain because of the use of a limited number of compression paddles in our healthcare system.

4. Our study's findings suggest a link between pain experienced during mammography and the behavior of the staff. So we suggest utilizing behavioral techniques to help alleviate pain in women undergoing mammography, especially those with symptomatic breasts.

CHAPTER – 10

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ANNEXURES

SANTOSH DEEMED TO BE UNIVERSITY (GHAZIABAD)

INFORMED CONSENT ENGLISH

NAME OF RESEARCHER: IRAM NAZ (MSc. MIT, Postgraduate student) [E-mail; naz.iram2020@gamil.com] [Contact: 6395852449]

I .....voluntarily agree to participate in this research study.

"Comparative Study of Pain Perception in Mammography: The Impact of Compression Paddles"

- I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind.
- The purpose and nature of the study were explained to me and I also had the opportunity to ask questions about the study.
- I understand that I will not receive any benefits for participating in this research.
- My identity will remain anonymous. This will be done by changing my name and disguising any details of my interview that reveal may identity of the people I speak about.
- In case of the participant's inability to read: The researcher has done an accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions.

---------- ----------

Signature /Thumbprint of research Participant Signature

Signature of researcher

LETTER OF ETHICAL CLEARANCE FOR DISSERTATION

FROM REGISTRAR OFFICE

SANTOSH
Deemed to be University
(Established u/s 3 of the UGC Act, 1956)

F. No. SU/R/2024/1344[46] Dated: 17.05.2024

Subject: Grant of Ethical Clearance for **Dissertation Protocol** Topic **"Analysis of Pain Perception During Mammography",** submitted by **IRAM NAZ,** student of M.Sc Medical Imaging Technology, 2022 Batch.

*****

With reference to the request for grant of Ethical Clearance for the Dissertation Protocol entitled **"Analysis of Pain Perception During Mammography", IRAM NAZ** is informed that the **Dissertation Protocol** submitted by him/her was considered by the **Screening Committee** of the **Allied Health Sciences** in its meetings held on 07.02.2024 and 29.02.2024. The recommendations of the **Screening Committee** were considered in detail by the **Institutional Ethics Committee** in its meeting held on **15.05.2024** and the same was **approved** by the **Ethics Committee** of the **Santosh Deemed to be University, Ghaziabad, Delhi NCR**.

He /She is informed accordingly for further necessary action.

17/5/24

[Dr. EZHILRAJAN. K]
REGISTRAR

SANTOSH DEEMED TO BE UNIVERSITY ★ REGISTRAR ★ GHAZIABAD, NCR DELHI

IRAM NAZ
M.Sc Medical Imaging Technology.

Copy to:

1. The Vice Chancellor
2. The Dean – Academics
3. The Dean, SMC&H
4. The Dean – Research
5. The Director - IQAC
6. HOD/ Course In-charge of the concerned Department.

Tasks	Tasks Duration	Start Date	End Date	Aug-Sep	Oct-Nov	Dec-Jan	Feb-Mar	Apr-May	Jun-Jul	Aug-Sep
Preparation of thesis proposal	21	15-07-23	05-08-23							
Presentation of thesis proposal	25	05-08-23	30-08-23							
Preparation & Submission Thesis Application in Ethics Committee	41	30-08-23	10-10-23							
Review of Literature	89	10-10-23	07-01-24							
Data Collection	80	17-02-24	24-05-24							
Data Analysis	7	24-07-24	31-07-24							
Finding & Recommendations	10	31-07-24	10-08-24							
Report Writing	30	31-07-24	30-08-24							
Submission of thesis	5	30-08-24	04-09-24							
Presentation of thesis	0									

PLAGIARISM CERTIFICATE

Comparative Study of Pain Perception and Anxiety in Mammography: The Impact of Compression Paddles

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